# The Dock & Harbour Authority



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# Libya Clears up War's Debris

## Dredges mud and mortar-bombs the Priestman way

The North African Ports received their full share of military attacks during the late war and, as the tide of battle swept back and forth, its debris accumulated as neither side was able or willing to carry out dredging operations.

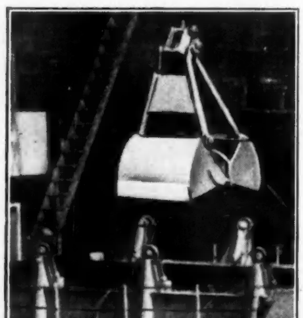
Faced with the problem of dredging its harbours the newly formed Government could not, for economic reasons, purchase its own equipment, but the Admiralty were able to offer assistance by sending one of their grab dredgers to carry out a certain amount of work in Tobruk and other ports.

As soon as circumstances permitted the Libyan Government allocated funds for the purchase of dredging equipment and without hesitation chose grab dredgers.

The wide variety of materials, from mud to mortar shells and from broken rocks to bombs, are all good reasons for this choice as no other type of dredger could, economically, handle them.

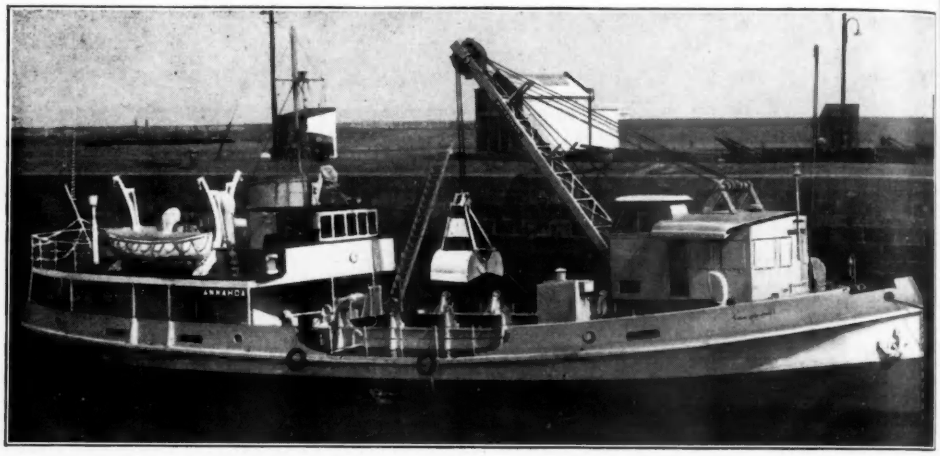
Priestman Brothers Limited of Hull were accordingly commissioned to supply a Single-Screw Diesel-driven Grab Hopper Dredger for service in the Libyan ports on the Mediterranean coastline, and in turn commissioned the well-known Leith shipbuilders, Henry Robb Limited, to build the vessel; themselves supplying the basic dredging equipment.

The vessel, the Annahda, is of the single flush deck type arranged with machinery aft, the hopper approximately amidships and the dredging crane forward.



*The Priestman Grab fills the 275-ton hopper in 88 minutes with a wider variety of spoil than could economically be handled by any other type of dredging equipment.*

The dredging crane is of the Priestman No. 50 size, driven by a 100 b.h.p. diesel engine and operates either a 70 cu. ft. Mud, a 55/44 cu. ft. Sand, or a 32/28 cu. ft. Wholetine Rock Grab at depths down to 50-ft. 0-in. below water-level.



Principal Dimensions of the "Annahda."

| | | | |
|---|---|---|---|
| Length between perpendiculars | 110′ 0″ | Draft loaded, mean | 9′ 0″ |
| Breadth moulded | 29′ 0″ | Hopper capacity, tons | 275 |
| Breadth overall | 30′ 6″ | Oil fuel capacity, tons | 20 |
| Depth moulded | 10′ 6″ | Engine b.h.p. | 420 |
| | | Engine r.p.m. | 320 |

On trials the 275-ton hopper was filled in 88 minutes from a depth of about 30-ft. 0-in. in a mixture of mud and shells.

The main propelling machinery consists of a Crossley two-stroke cycle oil engine developing 420 b.h.p. at 320 r.p.m. and on trials a speed of 9.33 knots was attained against a contract speed of 8.5 knots. The deck machinery is all electrically driven with the exception of the steering gear which is hydraulically operated. Two auxiliary engines are situated in the engine room each driving a 15 kw. generator and the necessary air compressors and general service pump. An electrically-driven fuel oil transfer pump is also fitted.

Accommodation is provided for a total of 11 men, part of this being arranged forward and part aft on the main deck. A saloon and galley are built aft alongside the machinery casings and the necessary toilet facilities are provided.

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## Permanent International Association of Navigation Congresses

### 19th CONGRESS, LONDON, 8th to 16th JULY, 1957

### Message from the President

RT. HON. THE VISCOUNT WAVERLEY,

P.C., G.C.B., G.C.S.I., G.C.I.E., F.R.S.

*Rt. Hon. The Viscount Waverley, President of the Congress.*

I am happy to have this opportunity of extending a warm welcome to the delegates of over fifty countries who will be attending the Nineteenth Congress of the Permanent International Association of Navigation Congresses. It is 34 years since the last congress was held in London and I hope that during their stay our visitors will be able to see many fine examples of development and technical progress in the different spheres of port construction, equipment and operations.

The various papers that have been prepared should produce stimulating discussions of value to all taking part and, together with the tours and inspections arranged for the latter part of the Congress, create a very real sense of international relations—the main object of the Association since its inception over 70 years ago.

I wish the Congress every success.

Waverley.

28th June, 1957.

## Editorial Comments

We would join the President, Viscount Waverley, Chairman of the Port of London Authority, in extending to all delegates of the XIXth P.I.A.N.C. Congress a hearty welcome to our capital city. During their stay in the United Kingdom, delegates and their ladies will have the opportunity of attending a series of social engagements, including visits to some of our beauty spots as well as to places of historic interest. We hope that they will be able to carry back with them to their own countries memories not only of useful and practical meetings, but also of pleasurable journeyings and bountiful hospitality.

**Post War Developments in the U.K.**

There are so many facets of port working that it is difficult to compress into a single issue the wide range of subjects which are of direct concern to the industry. We have, however, endeavoured to make the articles in this special P.I.A.N.C. number as comprehensive as possible and of international interest.

The account on the following pages of the rehabilitation and development of a number of the United Kingdom ports which were devastated or severely damaged during the Second World War is impressive. Even so, the story is not complete and space does not permit us to give details of the engineering works and improvements successfully accomplished at many other ports in the country.

Despite the competing demands of other industries and the shortages of materials and labour, which were the inevitable aftermath of years of war, port authorities, civil engineers and their staffs, have made remarkable progress in the work of restoration so that, to-day, the tonnages of imports and exports handled throughout the country far exceed pre-war figures.

The manufacturers of the many and varied types of plant and machinery and mechanical handling devices, which are essential for the equipment and maintenance of a modern port, have also overcome many of the handicaps imposed by the switch-over from war to peace production. A careful study of the advertisement pages will show that the United Kingdom still stands in the forefront as a manufacturing and exporting nation, and can supply technical advice and modern equipment to any country needing these services.

## Editorial Comments—*continued*

**Modern Dry Docks.**

Owing to the continuing expansion in the size of modern ships and particularly of tankers, the need for a corresponding increase in the size and number of dry docks is imperative. We are therefore publishing during the ensuing months a number of articles concerned with the design, construction and equipment of dry docks. In view of this proposed series, particular interest attaches to the papers which will be read at the Congress concerning the berthage and acccommodation for large oil tankers and on maritime locks and graving docks.

The importance of this subject needs no emphasis and the survey which we propose will be as comprehensive as circumstances permit. It may well be that delegates to the Congress will be in a position to supply useful information for this purpose; if they can do so, their co-operation will be cordially welcomed.

**Resistance of Timbers to Marine Borers.**

Notwithstanding the advances of modern science, the answer to the problem of protecting timber from the depredations of marine borers has not yet been found. The damage done by these marine pests throughout the ports of the world costs millions of pounds a year and the useful research work being conducted by many scientists in their endeavours to overcome the menace has frequently been referred to in this Journal. This month we publish a review of the present position, which gives a survey of the experimental work which is being conducted at many laboratories and research stations throughout the world.

As is pointed out by the author, the amount of information concerning the habits of marine borers and their methods of attack is far from complete and further investigations and the collating of data will do much to assist in discovering an antidote.

**Dock and Quayside Lighting.**

The adequate lighting of docks, quays, cargo handling appliances, railway sidings, etc., is essential for the efficient working of ports and for the expeditious handling of cargo. It is therefore necessary that dock and harbour authorities should keep abreast with the many changes and noteworthy improvements which have been effected in the lighting industry during recent years.

In view of the complicated nature of port operation, it is usually considered advisable to obtain the guidance of lighting specialists when installing lighting systems of major importance. The article on page 107 reviews some of the lighting problems peculiar to the port industry and gives practical advice concerning their solution.

**Fires in Ships and in Ports.**

Another subject of international concern is the problem of fire prevention. In the past few years, there have been many disastrous ship and warehouse fires which have caused widespread damage and great financial loss. Docks present a concentration of fire risks by the very nature of their construction, with large warehouses and other buildings crowded closely together into relatively small areas and stocked with various commodities, some of which may be highly combustible.

The quelling of incipient fires is of the first importance—one can only guess how many small fires would have become major conflagrations if immediate action had not been taken. The expenses involved in the organisation of effective fire prevention schemes is therefore negligible compared with the losses caused by a serious outbreak.

Readers will remember that, in our March, 1955, number, we referred to a Report by the Association of Municipal Corporations which recommended *inter alia* that each port and dock authority should set up a fire preventative Committee on which the local fire brigade is represented.

The author of the article on page 112 of this issue holds similar views. He points out that fire prevention schemes can only be successful if all the interests concerned give their wholehearted collaboration. His suggestion that all port authorities should seek to form a unified policy should receive serious attention.

**XIXth Congress Papers.**

Although some of the subjects covered in the foregoing comments do not come within the range of the papers being presented at the XIXth Congress, they, nevertheless, are of considerable importance to the efficient working of ports.

Details of the Congress papers have already been given in previous issues of this Journal. There are two Sections, one dealing with Inland Navigation and the other with Ocean Navigation. The authors of the papers have made valuable contributions which will no doubt stimulate lively discussions from the many engineers and technicians who are attending the meetings from all over the world. In view of the importance of the topics to be debated at the conference, we hope in future issues to give a resumé of the proceedings.

It now only remains to us, at the opening of the Congress, to wish all connected with it every success in their attempts to resolve some of the maritime problems which are common to all nations.

## Improvements to U.K. Inland Waterways

The British Transport Commission recently approved a £959,000 programme of improvements for the River Severn and the Gloucester and Sharpness Canal.

This programme is part of the £5½ mn. development plan, announced by the Commission in January, 1956, for their principal inland waterways, and, when completed, will further increase the substantial traffic carried on this important waterway route to the Midlands.

The work now to be undertaken on the River Severn and the Gloucester and Sharpness Canal comprises:—

Bank protection £258,500; special dredging £49,000; construction and extension of locks £312,000; mechanisation of lock gates, sluices and bridges £59,000; reconstruction of swing bridges £89,000; dredging plant £149,000, and workshops and other premises £42,500.

Steel and concrete piling is to be driven along nearly five miles of the banks of the Gloucester and Sharpness Canal, where adequate bank protection is essential on this unbanked waterway owing to the frequent passage of powered craft.

On the River Severn extensive steel piling works will safeguard from erosion the lock wing walls at five locks; Upper Lode (near Tewkesbury); Diglis (Worcester); Bevere, and Holt (both near Worcester), and Lincomb (near Stourport). A sharp bend in the river below Westgate Bridge, Gloucester, which is steadily becoming more acute as the result of erosion on one bank and silting on the other, is to be given steel piling protection.

On the River Severn, where the navigable channel runs in parts through solid rock which outcrops in the river bed, special dredging work is to be undertaken to widen the narrowest of these channels. Similar dredging will also be carried out on the Gloucester and Sharpness Canal, which is increasingly being used by coaster type craft, to improve the underwater width of the channel on certain narrow sections and at acute bends.

An entirely new lock is to be built at Gloucester to augment the existing Gloucester Lock, which controls the entrance to the River Severn. The new lock will measure approximately 250-ft. long by 25-ft. wide and will be able to accommodate either one large and one small tanker or two small tankers. Its construction will involve a new swing bridge across the lock, road diversion works and some re-arrangement of railway lines within the Gloucester Docks area.

At Diglis, Worcester, the smaller of two parallel locks is to be enlarged to the same size as the other up-river locks at Stourport, and in order to quicken the passage of craft, the principal locks on the River Severn are to be fitted with mechanical appliances so as to enable the gates and sluices to be operated simultaneously.

A swing bridge at Gloucester and another at Sharpness, both of which carry road and rail traffic, are also to be mechanically operated and ten existing wooden swing bridges across the Gloucester and Sharpness Canal are to be replaced by quicker-opening steel bridges which will help to speed up the canal traffic.

The River Severn and the Gloucester and Sharpness Canal together form an important water route linking the Bristol Channel with the industrial Midlands. Carryings on this waterway have increased from 534,000 tons in 1949 to over 800,000 tons in 1956.

# Post-war Port Developments in the U.K.

## Impressive Rehabilitation and Improvement Works

OVERSEAS members of the Permanent International Association of Navigation Congresses who are attending the 19th Congress in London will also have opportunities of visiting British ports where they will doubtless be presented with concrete evidence of the efforts made both by statutory authorities and by private concerns to overcome the devastations of war and to develop and improve the port facilities so vital to the post war recovery of our maritime nation.

We believe that Britain may be justly proud of the achievements of these authorities and maritime business interests, large and small, throughout the country, to re-establish and surpass their pre-war levels of activity despite the many severe handicaps.

It will be, however, manifestly impossible for our visitors to see more than a very small fraction of the work that has been and is being done, and it will be difficult for them to judge merely from what they see the scale and character of the total national effort. For this reason, "The Dock and Harbour Authority" has devoted a considerable proportion of this special P.I.A.N.C. edition to an account of post-war developments and improvements in the more important ports in the country.

In this account, certain general features reveal themselves. First is the co-operative endeavour of public authority and private enterprise to maintain our ports as efficient modern terminals comparable with any in the world. Secondly, there is a universal avoidance of grandiose schemes indulged in mainly for the gratification of the planners. The projects described are invariably the results of careful assessments of the needs of the maritime interests and the public whom the ports exist to serve. This had led to comparatively few very large and dramatic schemes having been undertaken, and perhaps this in turn has led to the British effort in this sphere having been somewhat overshadowed on the pages of world publicity by more sensational developments elsewhere.

Nevertheless we are confident that if our P.I.A.N.C. visitors are enabled to co-ordinate what they will see with their own eyes with an appreciation of the extent of the total national effort, they will be convinced of the steady determination of those responsible for the running of our ports to maintain Britain's proud place amongst the maritime nations of the world, and we trust that the following account will assist in this appreciation.

We are grateful to the authorities concerned for their several contributions which have made this comprehensive article possible.

## The Port of London

Before the pattern of the Port of London Authority's post-war reconstruction and development can be clearly seen it is necessary to sketch in the background against which it appears.

In the immediate post-war period the Authority were faced with a situation wherein 30 per cent. of their warehouse capacity and 25 per cent. of their transit shed accommodation, together with much other property, plant and installations, had been destroyed, in addition to accommodation and installations seriously damaged. This period also saw the volume of traffic, which had virtually disappeared during the war, rapidly recovering its pre-war proportions.

The tonnage of goods handled within the Port of London Authority's Docks was 16½ million tons in 1938, had recovered to 13¼ million tons by 1948 and reached 17½ million tons in 1956. These figures are in themselves a measure of the success of the Authority's post-war policy and its implementation.

The immediate need was to provide berths, transit and storage accommodation and ancillary equipment and installations as rapidly as the difficult labour and materials position would allow and, to effect this, the emphasis was placed on the repair and reconstruction of those damaged or destroyed facilities for which the need was greatest. At the same time such improvements were introduced as were possible within the limits of the situation.

Two features of this phase of the post-war period are significant. War-time destruction, though serious and extensive, did not, except at Surrey Commercial Docks, completely devastate great areas of the Docks as had been the case in certain Continental ports. There was thus neither the need nor the opportunity to embark upon very large schemes of reconstruction and development.

Secondly the inter-war years had seen great progress of expansion and improvement in the Port of London Authority's docks which rendered them amongst the most modern in the world. Following the formation of the Port of London Authority in 1908, a twelve million pound development programme was carried out culminating in the opening of the new King George V Dock and Entrance Lock in 1921.

Between 1925 and 1930 there were executed the Tilbury Dock improvement works comprising a new Entrance Lock (994-ft. x 110-ft. x 46-ft. below T.H.W.), a new dry dock (750-ft. x 110-ft. x 37-ft. 6-in.), an extension of the wet dock and a new floating passenger landing stage and baggage hall. During this same period large scale improvements were carried out at the West India Dock and Millwall Dock which included a new Entrance Lock (584-ft. x 80-ft. x 35-ft. T.H.W.) and three new cuttings to inter-connect the wet docks of the system.

These works were followed by major improvements at the Royal Group of Docks which comprised the virtual reconstruction of the Royal Victoria Dock, where the finger jetty system was replaced by modern marginal quays with five modern three-storey warehouses, each 500-ft. long x 150-ft. wide, the widening of the north quay of the Royal Albert Dock, and the deepening of the passage connecting the two docks.

As the major need has therefore not been for large scale development schemes, the immediate post-war years have been taken up with a large number of works each of comparatively moderate expenditure and a smaller number of medium size schemes. A mere catalogue of these works would not be enlightening but a discussion of the planning considerations involved with examples to illustrate the salient features may be of interest.

### Impact of Mechanical Handling

The quay crane has for decades been the main item of mechanical handling equipment in the Port of London, as in most European ports, and still retains this position, but a significant post-war feature is the ever growing use of other types of mechanical handling equipment particularly mobile cranes and fork-lift trucks. This type of equipment requires clear and uncluttered external paved areas and, within sheds, heavier permissible floor loads, greater head room, higher and wider doors and fewer columns.

There is a demand for wider roads, more open storage and parking spaces and wider quays and this occurs at the same time as a demand for larger transit sheds for a given length of berth. The latter is brought about by the greater capacity of modern ships of a given length produced by improved design and greater draught. Within the restrictions of existing dock areas, multi-storage sheds are frequently the only means of providing the additional shed areas required.

### S.W. India Dock. Sheds Nos. 10 and 11.

Two new berths in the South West India Dock are examples of this trend. The site is a peninsular 355-ft. wide already provided with transit sheds along its southern side. A "false" quay on the north side was constructed to give a further 25-ft. of width and also to enable the berth to be deepened. A 50-ft. quay apron 1,332-ft. long with 13-ft. 6-in. gauge crane tracks and two rail tracks is backed by two, reinforced-concrete framed, brick

## *Post-war Port Developments in the U.K.—continued*

panelled, three-storey sheds of plan area 432-ft. x 128-ft. On the quay side each upper floor has a landing verandah 15-ft. wide. On the land side, the loop holes, which are staggered, are served by travelling roof cranes which also plumb the loading banks and rail-tracks. The ground floor is 24-ft. 6-in. high to permit high piling by fork-lift trucks and to accommodate mobile cranes. Completed in 1954, the work cost somewhat less than £900,000. The sheds are served by a wide road and ample rail tracks down the centre of the peninsula.

### Two-Storey Sheds

**Surrey Commercial Docks. No. 8 Warehouse.**

No. 8 Warehouse, Surrey Commercial Docks, is an example of a two-storey transit shed, again on a peninsula site but this time the width of the peninsula is only 245-ft. and the shed has a quay apron on both sides. 355-ft. long x 150-ft. wide it has 13-ft. wide verandahs on the upper floor. At the deep water berth on the north side the quay is 38-ft. wide and at the barge berth on the south side where allowance is made for road vehicles, the width is 57-ft. A feature of the Port of London is the high proportion of cargo distributed by barge and the planning of this shed, which permits cargo discharged on the north berth to be passed through the shed for sorting and delivering to barge on the south berth has proved highly successful.

**North Side, Shadwell Basin.**

At the north side of Shadwell Basin, London Docks, on a site only 160-ft. wide, a two-storey shed 60-ft. wide has been built with a 28-ft. quay apron, leaving 70-ft. at the rear for road and parking space. A 10-ft. verandah is provided on the upper floor on the quay side and, so as not to lose shed space, this floor is cantilevered out over the road at the rear.

In this shed and in the previous example, the ground floor clear head room is over 20-ft. and the dimensions of the doors exceed 20-ft. x 20-ft.

### Quay Cranes

As stated earlier, the quay crane remains by far the most important item of mechanical equipment in use in the Docks. The Authority has to a very large extent standardised on the use of 3-ton and 5-ton level luffing electric portal cranes and since the war over one hundred and eighty 3-ton and thirty-five 5-ton cranes have been purchased and more are on order.

The salient details of the modern cranes are given in Table (1).

Table 1.

| Safe Working Load | Motors: Hoist | Motors: Travel | Motors: Slew | Motors: Luff | Rail Gauge | Radius: Max. | Radius: Min. | Height of lift | Depth of Lower | Weight of Crane (Est.) | Max. wheel load (15 lb. wind) | No. of wheels per corner |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 ton | 63 b.h.p. 630 r.p.m. | Two of 10 b.h.p. 700 r.p.m. | 10 b.h.p. 700 r.p.m. | 5 b.h.p. 700 r.p.m. | 13′ 6″ | 65 ft. | 20 ft. | 70 ft. | 40 ft. | 83 tons | 25 tons | 1 |
| 3 ton | 63 b.h.p. 630 r.p.m. | Two of 10 b.h.p. 700 r.p.m. | 10 b.h.p. 700 r.p.m. | 7 b.h.p. 500 r.p.m. | 13′ 6″ | 80 ft. | 22 ft. | 70 ft. | 45 ft. | 97 tons | 18 tons | 2 |
| 5 ton | 90 b.h.p. 630 r.p.m. | Two of 10 b.h.p. 700 r.p.m. | 15 b.h.p. 700 r.p.m. | 10 b.h.p. 700 r.p.m. | 13′ 6″ | 80 ft. | 22 ft. | 70 ft. | 45 ft. | 112 tons | 16 tons | 3 |
| | | | | | Supply :— | D.C. 460/4 | 80 volts. | | | | | |

There has been a continual replacement of the older hydraulic and electric quay cranes since the war. The modern cranes are of the full portal, crank-luffing type powered on all motions by D.C. electric motors. The cranes are built to conform with B.S. 2452, Class II, type "A," although they are occasionally used for grabbing at a reduced safe working load.

Experience over the past twenty years with this type of crane has shown the need for certain improvements. some of which are as follows:

The older cranes had drum-type controllers on all motions with contactor panels for luff and slew. The repair of drum controllers constitutes a major item of maintenance and they have now been replaced by "joy stick" type combined master controllers for the luffing and slewing motions and a smaller controller on the hoist motion with contactor panels on all three motions, thus allowing for easy control on all three motions simultaneusly.

To provide a higher standard of illumination in the working area the portal is fitted with four 1,000 watt scuttle fittings. Tubular jibs have replaced normal structural sections thereby reducing maintenance costs and slewing weight. Jibs of both triangular and box sections are being used. 6 x 36 construction ropes have been adopted to increase hoist rope life.

Grease lubricated ball bearing cast steel sheaves have replaced fabricated oil lubricated sheaves.

A completely tubular construction crane is now being developed with the object of further improving structural maintenance, and incidentally the appearance of the crane.

A small number of A.C. cranes has been installed. These generally follow the lines of the D.C. cranes and have been fitted with high speed "Oportor" control on the hoist motions.

The leading features of the operating characteristics are shown in the following Table (2).

Table 2.

| Safe working load | Max. Radius | Hoist Speed: Full Load | Hoist Speed: Half Load | Luff Speed (full load) | Slew Speed (full load) | Travel Speed |
|---|---|---|---|---|---|---|
| 3 ton | 65 ft. | 240 f.p.m. | 300 f.p.m. | 120 f.p.m. | 1½ r.p.m. | 100 f.p.m. |
| 3 ton | 80 ft. | 240 f.p.m. | 300 f.p.m. | 120 f.p.m. | 1¼ r.p.m. | 85 r.p.m. |
| 5 ton | 80 ft. | 200 f.p.m. | 280 f.p.m. | 120 f.p.m. | 1¼ r.p.m. | 65 f.p.m. |

### Mechanical Handling

The introduction of palletisation and the mechanisation of cargo handling generally has proceeded gradually after careful consideration as to which operations would most benefit thereby and having regard to the many problems which accompany mechanisation, not least of which is labour relations. As an example of what has been achieved, at India and Millwall Docks among many operations which have been mechanised, the handling of fresh fruit has been virtually fully mechanised and at Surrey Commercial Docks considerable progress in the mechanisation of timber handling has followed operational studies. The extent to which mechanisation has proceeded may be judged from the fact that at the former dock group there are concurrently in operation some 40 fork-lift trucks, 70 electric platform trucks of three ton capacity, 50 mobile cranes and sundry other equipment, such as electric conveyors and squeeze clamp trucks.

## *Post-war Port Developments in the U.K.—continued*

West India Dock, Nos. 10 and 11 Sheds. Note landing balconies on the quayside and roof cranes at the rear.

**Timber Storage Sheds, Surrey Commercial Docks.**

The handling of timber has been planned on a full comprehensive basis, the considerations including the design of the timber storage sheds. These are open sided and have a clear head room of over 30-ft. to permit unrestricted use of mobile cranes. The sheds are divided into bays of 65-ft. span, each with a central concrete alleyway, 11-ft. wide, on which the mobile cranes operate.

In addition to the very extensive rehabilitation of damaged timber storage sheds, 400,000 sq. ft. of new storage to the above general design have been provided since the war. Open storage provided with concrete alleyways on the same principle as the covered storage constructed since the war, amounts to over two million square feet.

**Acorn Yard Shed.**

The principle of designing sheds to permit the maximum efficiency of mechanical handling is illustrated by a shed recently built at Acorn Yard, Surrey Commercial Docks. This shed comprises an open sided section of 40,500 sq. ft. and an enclosed section of 81,000 sq. ft. The latter is designed to store plywood, hardwood and softwood. The operating module for plywood is 25-ft. (two 7-ft. sections and a centre gangway of 11-ft.). For timber, the module of 65-ft. referred to above can be reduced to 62-ft. 6-in. A span suitable for both operating modules is thus 125-ft. and this has been adopted for the building. The roof has been designed on the "umbrella" principle, as giving the greatest economy for a multi span building of this clear span.

Sections of the framed and sheeted walls are designed so that they can be easily removed if the shed is to be used for long periods for the storage of softwood which requires through ventilation.

To permit of the greatest flexibility of use the floor of the enclosed section is paved throughout in reinforced concrete.

### New Building Techniques

The Acorn Yard shed illustrates a further feature of the Authority's post-war reconstruction, namely the use of new building materials and techniques where these are merited by reason of shortages of materials or because they lead to economies either in first cost or maintenance or a combination of these factors. This shed is of all welded tubular steel construction, selected on grounds of lower first cost and weight. It is anticipated that maintenance painting costs will also be reduced. The walls are clad in corrugated galvanised steel sheeting. The roof sheeting is asbestos cement with corrugated glass roof lights and the sliding doors which are 20-ft. wide x 22-ft. high, are panelled with self-coloured, glass-fibre-reinforced. plastic sheets.

**No. 19 Berth, London Docks.**

A further example of this feature is the transit shed at No. 19 berth, London Dock. The shed is 150-ft. wide and is constructed of prestressed concrete, three pinned portal frames of 75-ft. span; probably the first use of this application of prestressed concrete. The design was adopted because of the acute shortage of structural and reinforcing mild steel which obtained at the time. This shed, as well as many others built or re-sheeted since the war, is clad with aluminium alloy sheeting.

### Road Traffic

A factor which has played an important part in post-war planning is the increase in road traffic as compared with rail. This has created a need for more and wider roads and more parking space. At Tilbury Docks, before the war largely served by rail, the swing to road traffic is illustrated by the fact that whereas before the war 12 per cent. of the tonnage landed was handled by road, to-day the figure exceeds 50 per cent. At this group of docks, to meet the changing circumstances, about 1½ miles of new reinforced concrete roads have been built and the main road traversing the docks from east to west is in course of being widened to 40-ft.

The need for both lorries and rail wagons to have loading facilities along the land side of transit sheds has provoked much thought in the planning of transit layouts. At the Royal Albert Dock an inset lorry loading bay clear of the rail tracks, constructed as an experiment, is proving very successful.

### Rail Traffic

**Permanent Way.**

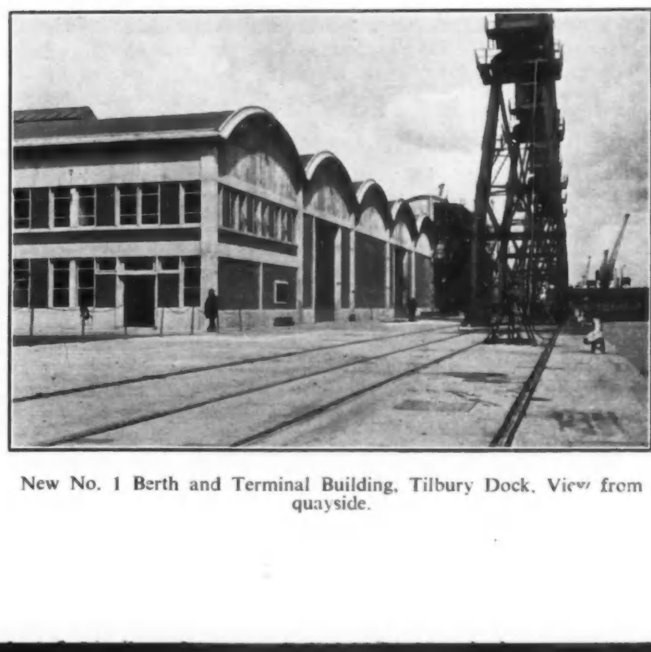
Despite the decrease in the proportion of rail traffic, it still forms an important part of the Port's activities and has not been neglected. As regards the permanent way, the Authority have changed their standard rail section (including crane rails) from 75 lb. to 90 lb. per yard (flat bottom), the latter section having been adopted to cater for the heavier loading now being experienced. Prestressed concrete sleepers are rapidly replacing timber except at crossings, with a view to reducing maintenance and the concommitant disturbance of working when sleepers have to be replaced.

A proprietary rail spike, which has replaced the dog spike on the Authority's railways on timber sleepers is being used experimentally with prestressed concrete sleepers, the spikes being driven into oak inserts cast into the sleepers.

**Locomotives.**

As regards locomotives, the Authority, pursuing a policy of reducing operating costs, are replacing the steam locomotives at Tilbury Dock by diesel electric locomotives.

The locomotives are of the 400 B.H.P. 0-6-0 rigid frame type, all wheels coupled, built by a leading manufacturer to the Authority's requirements. They are powered by two 200 B.H.P. diesel generator sets having high speed diesel engines with super



New No. 1 Berth and Terminal Building, Tilbury Dock. View from quayside.

## *Post-war Port Developments in the U.K.—continued*

chargers. The leading and trailing axles have traction motors driving through spiral bevel boxes and final spur driving. Either one or both generator sets can be used, dependent on road conditions. This arrangement. together with the low height of the diesels, has made possible for a centre cab with above average visibility in both directions.

It was desired to keep the mechanism of the locomotives as simple as possible to safeguard the equipment, minimise maintenance and give the best possible conditions for the driver.

To obtain these requirements, the following steps have been taken. To obviate the engine noise which is a disadvantage on diesel locomotives, the cab has been sound-insulated, resulting in a considerable reduction of the noise level. The maximum amount of glass has been incorporated to give excellent visibility all round, the front and the rear windows having been fitted with wipers. Cab heaters have been fitted.

Dual control permits driving from either side of the cab. Braking and sanding is pneumatic, the former on to clasp brakes on all wheels.

To safeguard the equipment the design is arranged so that the engine shuts down if the coolant temperature becomes excessive, if the lubricating oil pressure falls below a certain minimum, or if the temperature of the traction motor rises above certain maximum. There is over speed protection and low air pressure brake assurance.

To minimise maintenance the axleboxes and coupling rods are fitted with roller bearings, the boxes and horns being fitted with manganese steel liners. The brake gear is bushed with "mintex" and the brake block is of C Y alloy. The generator and the engine compartments are fitted with filter panels and the latter with oil bath cleaners. The whole of the cab work is readily removable.

The leading features of the locomotive are:

Loco weight: 48 tons.
Maximum T.E.: 30,000 lbs.
Engine: Rolls Royce C6 SFL supercharged.
Installed H.P.: 1,800 R.P.M.—2 of 200 B.H.P., total 400 B.H.P.
H.P. available for traction: 1,800 R.P.M.—370 B.H.P.
Traction generator: continuous rated self ventilated 6 pole single bearing. 124 K.W.
Traction motors: continuous rated self ventilated 143 S.H.P., 1,330 R.P.M.
Gear rates: 22.85 : 1.
Battery: Lead acid 24 cells, 77A/L at 5 hour rating.
Length over buffers: 26-ft.
Width overall: 8-ft. 5½-in.
Wheel base: 11-ft.
Fuel tank capacity: 400 gallons.
Minimum rail clearance: 6½-in.
Fuel system: direct injection.
Lubrication system: dry sump.

A special maintenance and repair shed for the diesel locomotives is being provided. This is designed on the multi-level principle which ensures working levels at platform and plate heights and that the men working below plate level do so in the correct posture. Wheels will be removed by hydraulic jacking and a small overhead crane provided of sufficient capacity to lift one engine generator set.

### Reconstruction to Serve Larger Ships

**Gallions Entrance Lock.**

From the foregoing examples of the many projects which the Authority have completed since the war, it will be seen that despite the concentration on the repair and reconstruction of damaged or destroyed facilities and accommodation, the need for development and improvement has never been overlooked. Particularly illustrative of this is the reconstruction of Gallions Lower Entrance Lock at the Royal Group of Docks completed this year. Opened in 1886 the lock is 550-ft. long x 80-ft. wide x 36-ft. below T.H.W. Its bottom is of the inverted arch shape, common to its period and well adapted to the shape of ships' hulls at that time. This shape and the chain operation of the lock gates reduced the

Gallions Lower Entrance Lock. Showing reshaped invert and new lock gates

effective depth by about 4-ft. when used by modern ships with approximately rectangular shape hulls.

When it became necessary to close and dewater the lock to effect structural repairs, the opportunity was taken to eliminate this restriction by cutting out the springings of the inverted arched bottom and replacing them with reinforced concrete "knee" sections so as to render the lock bottom more nearly rectangular in section to suit modern hulls. The chain operated gates were replaced by welded steel, buoyant, tank gates, electrically operated. The repair, reconstruction and modernisation of the lock cost about a million pounds.

**Canada, Greenland Passage, Surrey Commercial Docks.**

The trend for certain classes of vessel to become deeper draughted has been recognised in the planning of another project now being executed at the Surrey Commercial Docks at an estimated cost of about £750,000. The passage inter-connecting the Canada and Greenland Docks is slightly under 60-ft. wide x 27-ft. 6-in. deep and is traversed by an hydraulically operated swing bridge. Its dimensions limit the movement of certain classes of vessel from the Greenland to the Canada Dock and to obviate this restriction this passage is being widened to 80-ft. and deepened to 31-ft. 6-in. below T.H.W. The swing bridge is being replaced by an electrically operated rolling lift bridge to modern road loading standards. The new bridge will be installed at a higher level than its predecessor to give a clearance of over 13-ft. above T.H.W. and thus enable barges to pass underneath without the bridge having to be raised. The deepening of the passage will involve the construction of two new 8-ft. diameter service culverts beneath the bottom of the passage.

In connection with this scheme a new general cargo berth approximately 500-ft. long has just been completed in the Canada Dock.

The need for additional berthage has led to the construction (now virtually complete) of a new Ocean berth at Tilbury Docks at a cost of £1.300,000. Designed at the request of the shipping companies to cater for the large Orient and P. and O. liners now planned, the new quay, which is of monolith construction, is some 850-ft. long. To provide additional manoeuvring space, the north side of the main dock has been cut back by about 300-ft. and thus widened to 900-ft. A new combined passenger and cargo shed has been built with a floor area of over 100,000 square feet. It is "T" shaped and has a quay frontage of 550-ft. Built to the highest modern standards, it is framed in reinforced concrete, supported on piles and has brick panel walls and reinforced concrete barrel vault roofing with a clear span of 120-ft. There are no internal columns and the clear height is 20-ft. The doors, 19-ft. wide x 20-ft. high, are of timber having plywood outer skins on a softwood core. The floor is paved with pre-cast concrete slabs (two metres square) on a 4-in. bed of sand. This type of

## *Post-war Port Developments in the U.K.—continued*

flooring, now widely used at Tilbury, permits the paving to be easily re-laid when settlement (due to the sub-soil conditions in the area) renders this necessary.

The building includes a passenger and friends reception hall with many facilities, such as cafeteria, bar and various offices. A friends viewing balcony has a commanding view of vessel and quay. Rail sidings and platforms, car parks and under-cover car loading bays are provided. The planning of the whole project is based on a careful consideration of personnel and traffic flow. The adjoining berth (No. 2) in the West Branch Dock has been reconstructed for a length of 880-ft. and provided with a steel framed transit shed of over 48,000 square feet.

### Electricity. Distribution, Illumination and Communications

**Distribution.**

The demand for electricity in the Authority's undertaking has risen continuously during the post-war years necessitating an examination of the existing distribution systems at each dock system.

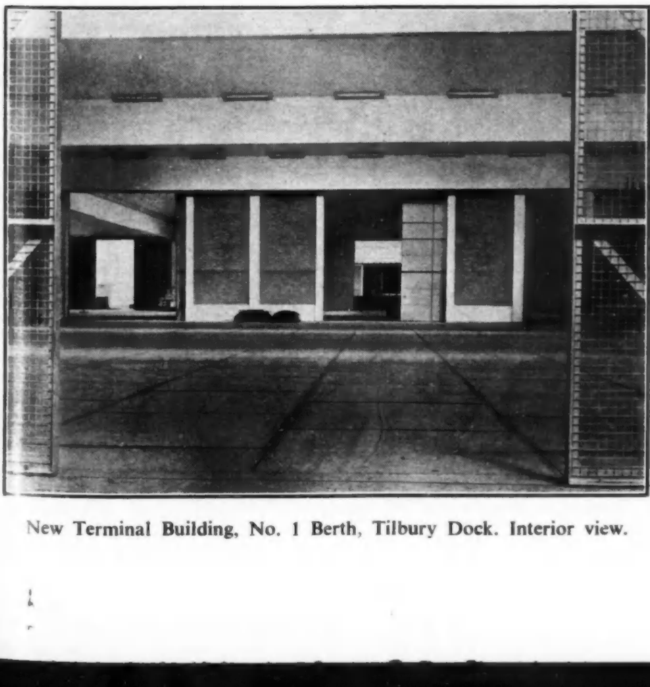
It has been decided to replace the traditional direct current distribution network drawing current from the public supply mains at a number of points on the periphery of each dock system, by alternating current systems having sub-stations located near centres of load and connected, as far as possible, by means of an 11,000 volt ring main laid by the Authority. The Electricity Boards furnish a high voltage supply at some convenient point in the ring main.

As a result of this decision, as many services as possible are being converted to A.C. working; transformers at the sub-stations provide 415 or 240 volt A.C. supplies for heating and lighting and some of the machinery, whilst essential D.C. supplies are maintained by mercury-arc rectifiers. New sub-stations of this type have been commissioned at Tilbury Docks and similar schemes are in hand for the King George V Dock and Surrey Commercial Docks.

In view of the high capital cost of rectifying plant the amount required is being kept to the minimum by replacing D.C. operated equipment by machinery suitable for A.C. working and several such quay cranes have been put into service at Tilbury Docks to be followed by others at Surrey Commercial Docks when the A.C. distribution system is complete.

**Illumination.**

Reconstruction of quays and sheds has provided the opportunity for improving the standard of lighting. Tungsten lighting using industrial fittings has generally been adopted as fluorescent lighting appears uneconomic at present. The latter type of lighting has been used in certain warehouses at London Dock where the number of hours in use and the intensity of illumination are higher than normal. Sodium discharge lamps have been installed, notably at India and Millwall Docks for lighting main roads in the docks. The lack of colour discrimination renders this type of lighting unsuitable for working areas and quays and colour corrected mercury discharge lamps are being used in such areas at Surrey Commercial Docks and Tilbury Docks. Further installations of discharge lamps for exterior lighting will follow as A.C. becomes more generally available in the docks.



New Terminal Building, No. 1 Berth, Tilbury Dock. Interior view.

**Communications.**

An installation developed in the post-war years is the Authority's V.H.F. radio-telephone service. At present the system is limited to vehicles and vessels owned by the Authority and it may be considered as a private or domestic installation. There are four separate but interconnected services forming the system, viz.: Police and Ambulance Service, River Service, Dredging Service and Dock Service. The services, except for the latter, operate through a central transmitter and are connected to it by land lines. The Dock service has separate frequency channels for each dock and the transmitter is installed in the respective Dockmaster's office. Mobile transmitters are provided in police vehicles and on motor cycles, on Harbour Service craft, salvage vessels, dredging craft and dock tugs. A total of 31 police vehicles and 48 marine vessels have equipment and a number of portable sets and "Walkie-Talkie" units are provided.

### Siltation and Pollution

**Investigations.**

The Authority has important duties as conservators of the tidal reaches of the Thames. Here pollution and siltation present serious problems. The pollution, arising from the enormous quantities of sewage and other discharges from the great metropolis, is being studied by a Government committee whose findings and recommendations are expected to be published shortly.

Siltation, which requires the Authority's fleet of dredgers to remove over three million cubic yards of spoil per annum from the River and Docks, is being studied by the Hydraulic Research Laboratory of the Department of Scientific and Industrial Research with the aid of a Tidal Model constructed by the Authority. These investigations, which are being carried out with the full co-operation of the Port Authority, have included the use of radio-active tracer elements to investigate the movement of silt. A scheme for the land disposal of dredged material which is at present dumped at sea, has been approved and will be commenced shortly.

**The Authority's Fleet.**

On the marine engineering side, dredger performance has been improved by the introduction of a forced lubricating system to the ladder rollers and bottom tumblers. This had led to reduced wear, lower fuel consumption, and increased availability and has permitted faster working speeds. A new self propelled 120-ft. bow lift salvage vessel with a 30 ton electric hydraulic winch has been built amongst other additions to the Authority's varied fleet.

### Conclusion

It has not been possible within the scope of this article to refer to the many important projects carried out by private wharfingers, dock companies, oil companies and others, nor has a fully comprehensive survey of the projects undertaken by the Authority since the war been attempted. It is hoped, however, that the examples briefly described in this article are sufficient to provide a picture of the post-war construction activities that have been and are being pursued by a Port Authority fully alive to the needs of the public and the shipping trade it serves and determined to meet them efficiently and economically.

### New Admiralty Floating Dock.

A floating dock for the Admiralty, capable of lifting ships of up to 6,000 tons displacement, was launched recently. It has an overall length of 450-ft., a width of 92-ft., and is 43-ft. in depth. Equipped with travelling cranes, on each wall, adequate diesel generating capacity, workshop and storage space the dock is fully capable of operating as a self contained unit.

*Post-war Port Developments in the U.K.—continued*

# Tees-side Ports

**Commissioners' Developments.**

The necessity for shipping and cargo handling facilities to develop in harmony with the extensive industrial developments on Tees-side has been fully appreciated on the River Tees and in 1946 the Commissioners, by Act of Parliament, were designated the Harbour Authority with powers to construct and operate at Lackenby an open dock, two oil jetties, a dock road and railway and all related facilities.

The two jetties and the road were completed by 1950 and have been in operation since that date.

**Oil Jetties.**

These jetties, which are identical in construction, can each accommodate tankers of 650-ft. in length and are provided with a normal dredged depth alongside of 37-ft. and 34-ft. below L.W.O.S.T. level respectively. The design, however, permits of ultimate dredging to 42-ft. below L.W.O.S.T. level if necessary.

Each jetty is 185-ft. in length, constructed of reinforced concrete in-situ beams and prestressed concrete deck slabs and supported on 18-in. diameter composite steel and reinforced concrete tubular piles with concrete hearting which are founded on hard marl and marl rock in special bored holes.

For the safe berthing of vessels and to protect the jetties from berthing stresses special spring fenders are fitted one at each end of each jetty. These fenders, which are of steel box construction faced with timber are located with a ball and socket joint 20-ft. below low water level and operate at deck level through a system of levers and spring wires. The maximum horizontal movement permitted is 2-ft.

The jetties are also fitted with hand operated derrick cranes for handling oil pipes.

The importance of the Commissioners' Oil Jetties to the future development of the area was emphasised at the end of last year when Shell-Mex and B.P. Ltd. brought into operation their oil distribution and bunkering depot 22 acres in extent established on land leased from the Commissioners immediately adjacent to the Jetties. The depot comprising 23 tanks has a storage capacity approaching 150,000 tons of various kinds of oil.

Adjacent to the Shell-Mex depot, also on land leased from the Commissioners, Imperial Chemical Industries Ltd. have established an oil installation covering 14½ acres which has been used for the storage of oil received over the Commissioners' Jetties since 1950 for use in their post-war Wilton Factory.

The Company's huge chemical works at Wilton and Hillingham, which are situated on the South and North banks of the river respectively, have been connected by a series of overland pipelines which run for a distance of 1,765-ft. under the river in a tunnel 9-ft. in diameter with 15-ft. diameter vertical shafts from the ground surface at each end.

**New Tees Dock.**

Work on the major project in the Commissioners development scheme, the five berth deepwater open dock at Lackenby, is proceeding. The site has been comprehensively investigated by means of test borings, 40 acres of tidal foreshore immediately adjacent to the dock have been reclaimed by pumping ashore sand dredged from the river during maintenance operations and nearly 1,000,000 cubic yards of overlying sand removed from the Dock site. Work is also proceeding on the removal by multi-bucket dredger of the stiffer materials composed of clay and marl.

The design of the works has been completed and construction is likely to commence in the near future on No. 1 Quay which will be over 3,000-ft. long and comprises five deep water berths each 600-ft. in length. The dredged depth alongside will be 32-ft. below L.W.O.S.T. level with provision to deepen this a further 5-ft. if required in the future.

The quay will be road and rail served and provided with modern cargo handling cranes and related facilities including marshalling yards, transit sheds and warehouses.

The quay structure will be 90-ft. wide flush decked and composed of reinforced concrete post tensioned cylinders 6-ft. 3-in. diameter with concrete and sand hearting, spaced in three rows, 30-ft. apart longitudinally, and founded on marl rock. The main beams and decking will be precast reinforced concrete members.

**Reclamation.**

The Commissioners' policy of reclaiming areas of tidal foreshore by pumping ashore a large proportion of the materials recovered during maintenance dredging operations of the main river channel is being continued. The reclamation of an area of 246 acres to the north bank of the river was completed in 1953 and has provided valuable land with river frontage for industrial development. Since then an area of 40 acres connected with the New Tees Dock has been reclaimed and work is now proceeding on a further 130 acres, in the same area.

**Dredging and other Craft.**

Since the end of World War II the Tees Commissioners, as part of an overall policy of developing the port to meet present and future needs, have modernised their River Fleet engaged on maintaining and improving the navigable waterway and the following new craft have been commissioned at a total cost of approximately £1 million.

**One Suction Hopper Dredger.**

Type ... Twin Screw Steam Sternwell with cutter gear

| | |
|---|---|
| Length overall ... ... .. | 232-ft. |
| Loaded Draft ... ... ... | 15-ft. |
| Hopper capacity ... ... | 1,000 cubic yards |
| Maximum dredging depth below water line ... ... ... | 53-ft. |
| Speed loaded ... ... ... | 10 knots |

**One Multi-Bucket Dredger.**

Belt drive

| | |
|---|---|
| Length ... ... ... ... | 153-ft. |
| Draft ... ... ... ... | 7-ft. 9-in. |
| Capacity ... ... ... ... | 1,000 tons per hour |
| Maximum dredging depth ... | 45-ft. |

Three self-propelled hopper barges, two of which have a carrying capacity of 760 cubic yards and one with a carrying capacity of 700 cubic yards.

A General Purposes Craft for buoyage, salvage and towing purposes, fitted with Echo Sounding equipment and capable of heavy lifts of 80 tons over the bow.

The first four vessels mentioned above are oil-fired steam driven and the last two are diesel engined with oil operated gear boxes and are fitted with bridge control.

A V.H.F. radio telephone system has also been installed by the Commissioners to facilitate the control of river operations, which links the Harbour Master's office, the Pilot Cutter, H.M. Customs Launch and the majority of the Commissioners' own craft.

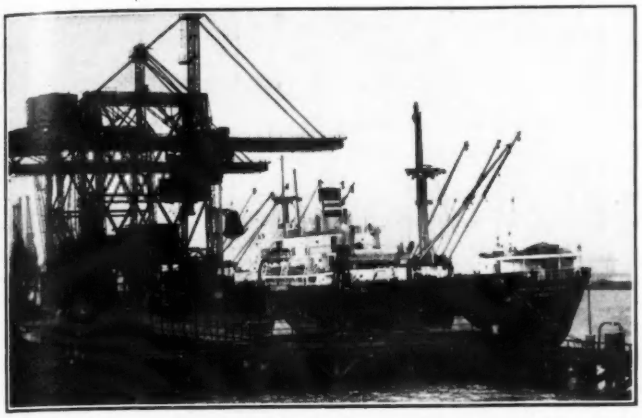
**Navigational Aids.**

The Commissioners have adopted the principles of the Uniform System of Buoyage and the conversion to this system of all the lights, buoys and beacons on the River Tees is almost complete. Concurrently with these alterations the majority of the gas buoys and beacon lights, which have operated for many years on oil gas manufactured at the Commissioners' workshops, have been converted to the use of propane gas.

At the river entrance the South Gare Breakwater light has been altered from paraffin vapour to electric operation and increased from 20,000 candle power to 100,000 candle power; a new radial flow "C" type diaphone fog signal has been fitted with a range of 3/4 miles incorporating the latest design of aluminium exponential type of resonator. A radio direction finding beacon has also been installed which is continuously operated on a range of 20 miles and is designed to transmit a low power signal when required for the calibration of ships' instruments.

Consideration is being given to the fitting of radar reflectors to the navigation buoys at the river entrance and the approaches to the Port.

# *Post-war Port Developments in the U.K.—continued*



12,000 ton ore carrier discharging iron ore at the South Bank Wharf of Dorman Long (Steel) Ltd.

**Riverside Wharves.**

Several of the public and private wharfowners on the Tees have extension or modernisation programmes designed to meet the needs of the rapidly expanding industries in the area and the following new riverside works have either been completed within recent years or are at present under construction.

**Dorman Long & Company Ltd.**

As part of a very large scheme of modernisation and new development to the Company's Iron and Steel Works, one of the largest in the country, an extension of the ore discharging facilities was completed in 1949. This comprised a new deep water wharf and two large ore unloaders each more than 1,000 tons deadweight which can grab up to 11 tons of ore in one lift.

The wharf which is 520-ft. in length is composed of thirty-three bents of cruciform steel piles driven in three rows 25-ft. apart. The piles are of composite construction each fabricated from one 20-in. x 6½-in. and two 10-in. x 5-in. R.S.Js. with suitable stiffeners. The front piles are generally 40-ft. long driven 7-ft. into Keuper marl, their heads being about 32-ft. below finished deck level. The upper portion from 3-ft. below dredged level at the piles is incorporated in cylindrical reinforced concrete piers 3-ft. 6-in. diam. These piers support the reinforced concrete crossbeams and deck slab which are partially constructed in precast sections and partially in situ. An independent fender system is provided supported on bearing piles with square coil springs near deck level.

The berth alongside which is suitable for vessels of up to 14,000 tons D.W. Capacity is dredged to a depth of 20-ft. below low water level but the design provides for a 5-ft. greater depth if necessary.

**South Durham Steel and Iron Co. Ltd.**

The ore discharging facilities at the Company's works at Cargo Fleet are being increased and in addition to considerable alterations to the works an extension to their existing wharf frontage is under construction.

This new wharf when completed will be 586-ft. in length with a dredged depth alongside of 20-ft. below L.W.O.S.T. and suitable for the accommodation of ore carriers of up to 14,000 D.W. tons.

The site is composed of hard clay and the design incorporates "Rendhex" No. 4 steel box piles in five rows 10-ft. apart longitudinally and 13½-ft. apart transversely which support the reinforced concrete beams and deck slab in combined precast and in-situ construction. The piles are driven sufficiently to permit of ultimate dredging to 25-ft. below L.W.O.S.T.

The wharf fendering is composed of vertical steel broad flange beams driven into the river bed and fitted with timber facings. Rubber buffers just below deck level form a spring cushion.

A large ore unloader will be sited on the wharf on completion.

**Central Electricity Authority.**

The North Tees Power Station at Haverton Hill has been enlarged in recent years by the addition of a complete new coal-fired station of 240,000 KW capacity complete with two new wharves, one for the reception of approximately 500,000 tons of coal per annum and the other specially equipped for the loading of ash for disposal at sea.

The coaling quay, which is 450-ft. long, is of concrete monolith construction in sections 44-ft. long x 30-ft. 6-in. wide and provided with a dredged depth alongside of 20-ft. below L.W.O.S.T. level. The quay has plain timber vertical fenders and carries a number of 7½ ton capacity grabbing cranes.

The Ashing Quay 400-ft. long is composed of two longitudinal rows of interlocking steel sheet piling 22-ft. apart tied together, filled between with hardcore and surfaced with concrete. A special concrete bunker is formed in a trench behind and below the quay level for the reception of the waste ash from which it is loaded into barges for disposal at sea by means of a belt conveyor system.

**Stockton Corporation.**

This local authority, which owns and operates one of the oldest quays on the river, extended this quay a few years ago by 300-ft. The original quay is composed of stone and mass concrete but the extension is constructed in "Larssen" No. 5 section interlocking steel sheet piles with tie rods and anchor piles. A dredged depth of 16-ft. below L.W.O.S.T. level is provided alongside.

The quayside craneways are in reinforced concrete supported on steel box piles independent of the quay structure.

**Tarmac Ltd.**

This firm, who are engaged in crushing and processing blast furnace slag, are constructing a riverside jetty and dredged berth for the accommodation of vessels up to 3,000 tons D.W. for the shipment of crushed slag to the South of England as part of a new development scheme adjacent to Dorman Long & Co.'s Iron Works at Eston.

The jetty, which is 194-ft. long, carries a ship loading conveyor and consists of a 15-in. thick reinforced concrete deck supported on two rows of piles. The front row are Larssen No. 4 steel box piles and the second row are steel broad flange beams. The structure is stiffened by diagonal and cross bracing and at each end and in the centre by additional piles. A berth 400-ft. long is provided alongside the jetty, dredged to a depth of 15-ft. below L.W.O.S.T.

**Middlesbrough Dock.**

The British Transport Commission have carried out post-war improvements to their Middlesbrough Dock by demolishing out-of-date equipment, clearing the then existing surface features on No. 10 Quay which is the longest in the dock and providing a flush concrete quay apron 70-ft. wide with four rail tracks, modern cranes and two transit sheds of modern design.

The two transit sheds which have a length of approx. 340-ft. have a span of 75-ft. and the roof of asbestos cement corrugated sheeting and glazing is supported by a welded steel portal frame giving the maximum headroom within the building. The height at the eaves is 22-ft. The walls are of brick with an adequate number of 20-ft. wide steel rolling doors provided both at the front and rear of the shed where there is a loading platform.

New road access has been provided together with adequate parking facilities and all ancillary services.

**Towage.**

The Tees Towing Company's post-war programme had added six new motor tugs of advanced design to the river fleet. The first three, which are of the harbour type, have been in service for some three years. They are propelled by geared diesel machinery and develop 750 horse power.

The fourth vessel is for coastal, rescue and heavy harbour work and is about to enter service. She is a large edition of the harbour type developing 1,100 h.p. in conjunction with a Kort movable rudder. She has a pull of 18 tons. The fifth and sixth vessels which are being built are Voith Schneider tractors. These tractors, which are primarily for stern and steering tug work, represent a new type of towage. The propellers which are placed forward, can exert thrust round 360° of their circumference. The tow hook is placed as far aft as possible and the engine in conjunction with the unusual design can move the tug in any direction.

*Post-war Port Developments in the U.K.—continued*

# The Port of Southampton

**Southampton Harbour.**

The drift of modern industry to the South of England accelerated by a growing independence of coalfields has had a very marked effect on the post-war development of the Southamtpon area. The Southampton Harbour Board has been very conscious of its responsibilities to old and new users of the port, collaborating closely in the planning and construction stages of the great projects which have come to fruition and in present developments.

In addition to the steadily increasing traffic using the British Transport Commission's Docks, a heavy traffic in tankers has developed with the construction of the new Esso refinery at Fawley. Other new major establishments on the west bank of Southampton Water are the C.E.A. power station at Marchwood and the Admiralty base, H.M.S. Diligence, at Hythe. There is also the possibility of a second refinery at Hook, on the east bank for the Caltex organisatiion. With the growth of these great undertakings has been a comparable expansion of many other waterside activities such as ship and yacht building; timber wharves and light industries varying from electronics to plastics.

With the increased traffic has come a need for improvements in the co-ordination of ship movements and for all aids to navigation leading to the quicker and safer turnround of ships of all sizes.

The tanker traffic in particular has complicated the problem as, although the tidal regime and channel pattern favour the handling of large ships, tankers do not operate to a precise schedule of arrivals and departures. Unlike passenger liners, which fit their comings and goings to the tidal cycle and a highly organised routine of transportation, commissariat and other factors which permit of accurate timing; tankers are liable to wide variations of time-keeping arising from the progress of various highly technical processes such as pumping and processing of the product, gas freeing and certification of tanks, etc.

With knowledge of these difficulties, the Southampton Harbour Board have, since the war, undertaken a considerable programme of improvements including dredging, the provision of additional navigational aids, and the organisation of a Port Operation and Information Service.

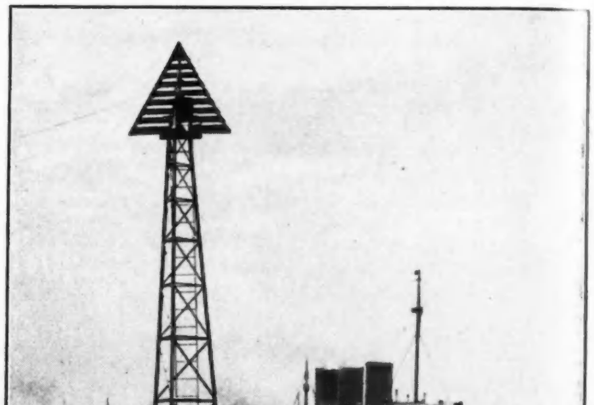
The first of these improvements, the major dredging of the entrance channels was described in the Dock and Harbour Authority for December, 1951. It consisted of a scheme of realignment of the channels at three places together with a substantial quantity of maintenance dredging, in all, a quantity of 2,750,00 cubic yards. Of this quantity, about 2,000,000 yards were pumped into a reclamation area on the west bank of Southampton Water between Calshot and Fawley.

The channel marking has been improved by the addition of a number of first-class buoys, some of them high focal plane type and provided with radar reflectors. Transit beacons have also been established at important points, notably, at the lower swinging ground where a pair of bridge transits of large size assisted the Queen liners to turn safely within the swinging ground available. Similar types of beacon mark the limits of the controlled anchorage for tankers at Netley.

The establishment of the Port Operations and Information Service has necessitated a considerable enlargement of the Board's signal station at Calshot and the provision of craft for a 24 hour patrol.

Both shore and floating supervision are under the command of master mariners who are in constant liaison with the Harbour Master, Dock Master, Refineries and other interested authorities so that all important ship movements may be organised to avoid interference and risk. Land and radio communications are used and will be augmented this year by the installation of V.H.F. radio telephony with frequency modulation and of a Port Radar installation of the highest efficiency. The radar will be sited immediately above the Calshot signal station, an ideal position for visual and radar viewing of the Solent area.

The problems of the future are not neglected. Among the research problems in which the Board has a substantial interest are one on the effects on port waters of large quantities of warm water



24-ft. 6-in. mast erected on the town quay to facilitate turn-round of ocean liners.

effluent from power stations. This is conducted jointly with the Central Electricity Authority and the University of Southampton. In connection with the possible establishment of an oil port at Hook, the Caltex Company and the Board have sponsored the construction and operation of a tidal model at the University for the study of problems connected with dredging and ship handling which may arise in the area affected.

In addition to its responsibilities as conservancy authority for the Port of Southampton, the Board owns and operates the Town Quay and Royal Pier. The former, which has 4,500 feet of berthing space, is used extensively by near-continental, coastwise, and Isle of Wight cargo traffic. The Royal Pier is used for passenger and car traffic to the Isle of Wight as well as being a favourite waterside rendezvous for residents of the town and visitors. A million persons use the pier annually. Both of these properties suffered extensively from war damage which has now been substantially repaired. The passenger and car traffic from the Town Quay and Royal Pier are materially assisted by the pontoon landing stages which since the war have been increased in number from one to five and in capacity from loads of five to thirty-five tons.

**Southampton Docks.**

The completion five years before the outbreak of World War II, of the New Docks at Southampton, added in a single operation a length of 8,014-ft. of quay representing an increase of 38 per cent. over the total length previously existing. The real percentage increase in capacity was considerably greater than this if account is taken of the fact that the new quay accommodation was dredged to a minimum depth of 40-ft., a depth which was maintained at only about 18 per cent. of the quay length previously constructed. Although the Port suffered extensive air raid damage during the war, this was mainly confined to the destruction of dockside buildings such as transit sheds and warehouses, with little or no major structural damage to the quays and drydocks themselves.

The emphasis in the post-war programme has therefore been inevitably on consolidation rather than on expansion, including the repair of air raid damage, the overtaking of arrears of maintenance accumulated during the war years, the improvement of passenger handling facilities to conform to the higher standards of

## *Post-war Port Developments in the U.K.—continued*

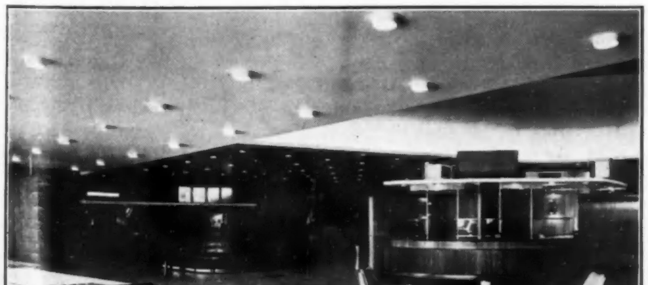
comfort demanded by the modern travelling public, and the reinforcement of the mechanical equipment of the port as one contribution to the acceleration of shipping turn-round, so essential in view of the active conditions which have prevailed generally in world trade in the post-war years.

Foremost among the projects for the improvement of passenger facilities was the Ocean Terminal, completed in 1950, which, with its spacious Customs Halls, its luxuriously appointed Waiting Halls, complete with every facility necessary for the convenience and comfort of passengers, its array of mechanical equipment including lifts, escalators and conveyors, for the rapid handling and dispatch of passengers and their luggage whether by road or by rail, and its capacious balcony for the accommodation of the public, whether passengers' friends or merely interested sightseers, has set a standard in passenger terminal accommodation, which has since been emulated but not surpassed in many of the ports of the world.

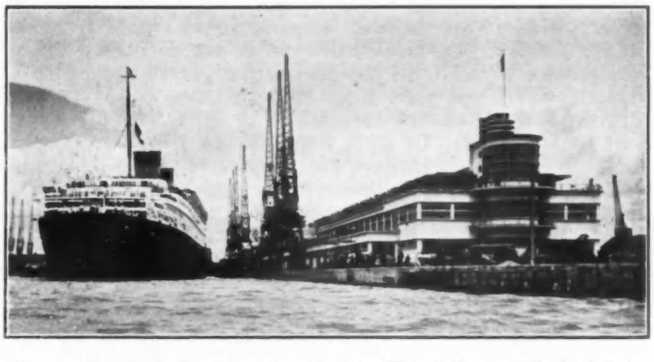
Detailed descriptions of the Ocean Terminal have already been published, and here it will be sufficient to refer only to the telescopic gangways on which a fairly extensive programme of engineering modifications has been carried out since they were first put into service. Like all prototypes, these devices have had their teething troubles, which were undoubtedly accentuated by the non-availability at the time of their original construction of some of the mechanical equipment most suitable for the purpose in view. The substitute equipment, whose use was enforced by these conditions, has now been replaced, and a substantial improvement in performance has resulted in consequence. The principal items of replacement have been the extension of hydraulic operation to the telescopic movement, and the provision of slip ring motors for the traversing movement, giving smoother and more controllable operation in both cases.

The completion of the Ocean Terminal was followed some two years later by the construction in the existing Sheds 107-8 of a new passenger Waiting Hall and Immigration facilities, which, although of much more modest dimensions and general standards than those of the Ocean Terminal, have nevertheless been singularly successful in handling the traffic from calling vessels, even including those of the dimensions of the "United States." An interesting feature of the work at this berth was the manufacture of two floating compressible timber fenders made in three sections, between which are sandwiched the compression elements consisting of stacks of lorry tyres filled with coils of rubber hose. Full-scale experiments on the energy absorbing capacity of such an arrangement were made in connection with the manufacture of these fenders.

A third project, also distinguished by the high standard of the passenger accommodation provided, has been the construction of the South African Terminal at Berth 102 which was completed at the beginning of 1956. This building, constructed on the site of



Passenger and Cargo Building at 102 Berth—Waiting Hall.



Ocean Terminal, Southampton Docks. The "Queen Elizabeth" is seen sailing for New York.

a previously existing single storey construction, and although almost entirely devoted to cargo purposes, nevertheless includes at one end a spacious and tastefully furnished waiting hall where all the facilities of the Ocean Terminal are reproduced, although on a much smaller scale. The ground floor cargo area of this building is noteworthy by reason of the wide spacing of the columns, designed to give the maximum manoeuvring area for mechanical cargo handling equipment. This feature, coupled with the relatively high loading requirements of the first floor, has given rise to columns and beams of unusually massive proportions which have nevertheless been refined to the maximum degree possible by the use of all welded construction and the employment of the plastic theory or collapse load method of design for the component members. It is hoped to publish a detailed description of this building in the pages of this Journal very shortly.

An important building which suffered complete destruction in the war, was the large reinforced concrete Cold Store situated at Berth 40. A new Cold Store, also in reinforced concrete, is now in course of construction at Berth 108 in the New Docks, and is designed to have an ultimate capacity of something over 4,000 tons of refrigerated cargo. The insulating medium to be employed will be slab cork, and refrigeration will be effected by means of electrically driven ammonia compressors operating partly through direct expansion and partly by air cooling. The accommodation which incorporates normal transit facilities on the ground floor will include some very cold chambers operating down to minus 20° Fahrenheit.

Items in the maintenance programme have included the overhaul of the caissons of the three largest graving docks, Nos. 5, 6 and 7, including the conversion of that at No. 6 from hydraulic to electric operation; the manufacture in greenheart timber of new gates for two of the smaller graving docks, Nos. 2 and 4; and the renewal partly in cast iron and partly in meehanite of the keel blocks at No. 5 graving dock, a relatively costly if somewhat unspectacular item of maintenance. The overhaul of the caisson at No. 7 graving dock was of interest because the exigencies of the docking programme necessitated that this should be carried out in one of the smaller graving docks where there was insufficient depth of water to accommodate the caisson in its normal upright position. It was therefore necessary to turn it over and dock it on the flat.

In the field of mechanical and electrical engineering there has been a formidable augmentation of the port's already impressive array of cranes. New cranes purchased since the war total 67, including quayside portal cranes, diesel electric rail cranes and petrol electric mobile cranes, and one electric drydock crane of 50 tons capacity. New battery operated cargo handling equipment has been obtained to the total of 80 vehicles including platform trucks, tractors and fork trucks, while 36 baggage conveyors and hoists have been installed, which figure includes the facilities already mentioned at the Ocean Terminal.

Along with the increase and replacement of the quayside cranes has gone an extensive programme of standardisation of the quayside crane tracks. With one or two minor exceptions, these are

## *Post-war Port Developments in the U.K.—continued*

now at a uniform gauge of 18-ft. with centre flange wheels, a facility which allows the easy interchange of cranes from one berth to another, a process carried out by the use of the 150-ton floating crane which forms part of the port's equipment.

During the eleven years from 1945-1956, the consumption of electricity in the Docks has risen from 11,300,000 units per annum, to 31,900,000 units. To cope with this, an extensive modernisation and augmentation of the electricity supply arrangements has been carried out, including the laying of many new H.T. and L.T. cables, the construction and equipment of new transformer substations, the intent of the programme being to standardise on alternating current, with the exception of the supplies for cranes, which remain direct current. In addition, the lighting arrangements on the quays, in the sheds and along the roads, have been brought up to modern standards. Finally, there has been a considerable extension of the application of broadcasting equipment to the control of passenger and road traffic movements, and, quite recently, the introduction of high frequency radio telephony for the control and direction of dock shunting engines.

Development by private companies and other organisations of properties on sites leased to them by the docks undertaking has also been on an extensive scale.

The constantly increasing tendency of ocean-going passengers to travel accompanied by their own motor cars, and the increased requirements for the storage and servicing of the cars of passengers absent on cruising holidays, have led to the duplication in the New Docks of the servicing premises devoted to this purpose in the Old Docks. In this connection, an interesting illustration of the variety of services which a passenger port of the nature of Southampton may be called upon to provide, has been the recent construction of facilities for the disinfesting from eel worm contamination of all cars to be shipped to the United States, a requirement which has arisen as a result of recent legislation in that country.

Although almost the whole of the commercial development of this kind has been concentrated in the New Docks, mention must be made of the handsome new depot recently completed in the Old Docks by Messrs. J. & E. Hall Ltd., for the servicing and repair of the domestic refrigerating equipment which is nowadays an essential part of the appointment of a modern passenger liner.

Finally, mention must be made of the completion by the docks authority in 1953 of a new canteen for dock workers at Berth 107 in the New Docks, which may be regarded as one of the finest of its kind in the country; and early this year, of a new central crane servicing depot at Berth 45 in the Old Docks.

# The Port of Leith

Since 1936 the main preoccupation of the Commissioners for the Harbour and Docks of Leith has been the formation and development of a new harbour between Leith and Newhaven now known as the Western Harbour.

After inspecting various protection and reclamation works in Holland, the Commissioners decided to adopt the Dutch principle in the construction of their new breakwaters. Between two parallel mounds of boulder clay, sand was pumped to form the core of the breakwater until the whole was raised to some 12 feet above high water. The clay forming the profile of the breakwater was then shaped to pre-determined slopes with horizontal areas or " berms " by which the force of the waves is dissipated. The whole surface above low water level was then covered with whinstone pitching laid on a bed of rubble, heavy blocks of rock being used to protect the toes of the breakwater. Leith was the first port in the United Kingdom to use this method of building breakwaters and experience has fully justified the claims that were made for this type of construction including the saving in initial cost and freedom from maintenance. The work was put in hand in 1936 and completed (not without difficulty) during the war, in 1942.

In all, an area of approximately 230 acres has been enclosed including 30 acres of reclaimed land and the siting of the two breakwaters has almost doubled the width of the entrance to the port.

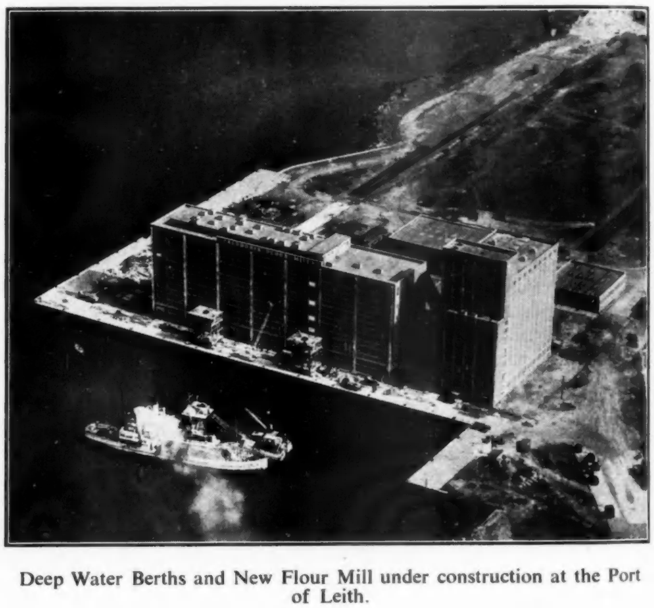
The cost of the work including reclamation of land and dredging was £550,000.

Fortunately Leith Docks escaped serious bombing during the war of 1939-1945 and in 1946 the Commissioners were able to commence the work of overtaking repairs and renewals postponed since 1939. At the same time their plans for developing their new harbour and improving the facilities at the existing docks were taking shape.

Agreement was reached with Messrs. Joseph Rank Ltd., the well known flour millers, for the construction of two deep water berths in the Western Harbour with the necessary dredging and the building of a flour mill on the ground behind the quays. This work was started in 1947. The pre-stressed concrete caissons which make up the quay walls were built ashore, floated into position and sunk, and then filled with concrete. The mill was brought into service in 1955, delays having been caused by restrictions on Capital Investment and shortage of steel.

Grain cargoes of up to 10,000 tons are discharged by suction plant direct to the mill, the silo capacity of which is 20,000 tons.

Considerable areas of ground are available in the Western Harbour for industries requiring the use of the port facilities. Good road and railway facilities have been provided.



Deep Water Berths and New Flour Mill under construction at the Port of Leith.

Another interesting piece of construction is the lighthouse and tide-signalling tower at the seaward end of the West Breakwater. By means of an electrically-controlled tide recorder the depth of water available to shipping entering the port is shown day and night. This is the first installation of its kind to be used in any port in the United Kingdom.

In 1954 Scottish Agricultural Industries Ltd. rented an area of ground reclaimed from the foreshore north of the Edinburgh Dock for the erection of a fertilizer factory. Provision has been made for the conveyance of the raw materials by overhead gantry from the discharging berth of the steamer to the materials store. To speed up discharge the Commissioners have ordered three 7½-ton grabbing cranes and these are now being built. Although there is still some constructional work to be done, the factory is in production, principally manufacturing sulphuric acid. The sulphuric acid plant is the largest of its kind in Scotland.

Also in 1954, the Esso Petroleum Company acquired ground from the Commissioners and built a coastal petroleum depot with pipelines from a discharging point at the Imperial Basin. There is spare ground for additions to the tankage and it is hoped this will soon be required.

## *Post-war Port Developments in the U.K.—continued*

Whilst the foregoing projects will bring additional traffic to the port, the needs of existing trades have not been forgotten and many improvements to accommodation and facilities have been made or are in hand.

Mention has been made of three heavy duty grabbing cranes being on order and in addition the following major items of plant and machinery have been provided or ordered, either as replacement of older units or as additional equipment:

**Edinburgh Dock**

| | |
|---|---|
| 14 (3—6-ton, 11—3-ton) | Travelling electric cranes |
| 19—1-ton | Electric capstans |

**Albert Wharf**

| | |
|---|---|
| 2—6-ton | Travelling electric cranes |

**Imperial Dry Dock**

| | |
|---|---|
| 1—15-ton | Travelling electric crane |

**General**

1—15-ton, 2—3½/5-ton, 2—2/3-ton and 2—3-ton Mobile cranes

1 Motor Launch with Echo Sounding equipment and 1 Hopper barge

An interesting development has been the discharge of large cargoes of scrap iron by means of electro-magnets and to enable this to be done the Commissioners adapted six of their D.C. quayside cranes for use with magnets.

Improvements to sheds were carried out at the Albert Wharf, where the accommodation was increased by approximately one-third, and at the Edinburgh Dock where old sheds were modernised and additional railway lines laid.

Considerable sums have been spent on new sub-stations, ring mains and cables to enable the increasing demands for electric current to be met. A policy of changing from hydraulic to electric power is being pursued and dock gates and bridges are in process of conversion.

During the ten years to 15th May 1956 almost one million pounds has been spent on new works.

In 1953 the Commissioners purchased the assets of the Leith Salvage and Towage Co. Ltd. including four tugs and since then they have operated the towage service at Leith, Granton and Burntisland. Two new diesel-engined tugs are on order and delivery is expected in the spring of 1958.

In common with most grain receiving ports in the United Kingdom, Leith has been suffering serious congestion as a result of heavy imports of bulk grain. Until 1955 the port's capacity was 36,000 tons in the Port Authority's two grain warehouses but with the coming into operation of Rank's Caledonia Flour Mills, already described, space for a further 20,000 tons was added. Even so, delays to shipping have continued and in March 1956 the Commissioners decided to provide additional silo space for 15,000 tons at their Imperial Dock grain warehouse. When this has been completed the total accommodation for bulk grain at the port will be 71,000 tons, nearly double what it was in 1946. Constructional work on the addition to the grain warehouse has commenced and it is hoped the building will be ready for use in the autumn of 1958. The total cost of this extension including railway diversions and improvements is estimated at £300,000.

# Tyneside

**Introduction.**

During the war years, 1939 to 1945, Tyneside was fortunate in suffering relatively little damage by enemy action, but she has not been content to rest upon the laurels of her good fortune and has demonstrated a keenly progressive outlook both on the part of her privately-controlled industries and in development works carried out on the river itself by the Tyne Improvement Commission.

The major developments in the port and on the river banks include the construction of three major dry docks, two new generating stations, a large factory for the manufacture of graphite blocks for nuclear fission moderation, the development of a marine propulsion research establishment, a large discharging plant for iron-ore imports, an up-to-date berth for coal shipment and a tanker cleaning installation.

In addition, Tyneside has seen a great increase of output both of basic heavy industries and the introduction of three light industrial trading estates, with the inception of a fourth trading estate. The growth in volume of light and heavy engineering work has more than compensated for the slow decline of the coal shipping trade and the area can look forward with confidence to the future.

The following are brief particulars of certain aspects of those works of a specifically maritime nature which have recently been carried out.

**Tyne Improvement Commission Iron Ore Discharging Berth, Tyne Dock.**

The berth, completed in November, 1953, is 820 feet long by 94 feet wide and has a depth alongside of 35 feet at L.W.O.S.T. It is constructed entirely of reinforced concrete in the form of a 27-inch thick deck slab or horizontal beam, carried on vertical piles without any bracing. The back of the quay is curtained by a line of pre-stressed concrete sheet piles built into the deck slab, the whole being tied back at 80 feet intervals by high-tensile steel cables to concrete blocks 130 feet behind the quay. The piles carrying the deck slab are of ordinary reinforced concrete, 19 inches square by 90 feet long, except at the east end where, owing to a geological fault, the shale rises to a comparatively high level and broad-flanged section steel piles, 50 feet long, encased with tubular reinforced concrete sleeves, were used.

The fendering system consists of timber-faced welded steel box section vertical beams spaced at 32 feet centres, 5 feet x 2 feet in cross section over the upper 25 feet, tapering to 18-in. square at the base, where they are arranged to pivot in a mechanite cup attached to the head of a 20-foot timber pile dollied down to dredged level.

The ore-discharging plant consists of five 10-ton electric travelling Kangaroo grabbing cranes loading on to wharfside conveyors with elevated bunker storage, weighing and dispatch facilities at the rear.

The plant has a nominal capacity of 1,000 tons per hour. Some of the actual outputs have been as follows:

8,223 tons in one 8-hour shift.

Highest individual crane output — 2,031 tons in 6 hours 30 minutes.

Highest average through-the-ship output for four cranes—942.4 tons per working hour.

**Tyne Improvement Commission New Coaling Berth at Whitehill Point, North Shields.**

The berth is designed to handle vessels of up to 10,000 tons gross at a rate of 1,000 tons per hour using two radial loading towers equipped with belt conveyors and fed through short connecting conveyors by two rotary tipplers capable of taking all mineral wagons of from 10 to 24½ tons capacity.

The quay, which carries the front portion of the two loading towers, is of reinforced concrete deck slab construction carried on reinforced concrete piles and is strutted horizontally to thrust walls constructed behind the existing river wall. The deck is designed to withstand a blow of 1,000 tons delivered at any point on the face line. Each loading tower is carried upon two bogies travelling on a radial 2-ft. 6-in. gauge track, the maximum bogie load being 105 tons on a 6-ft. wheel base. The piles are designed as struts encastré at their tops and pin-jointed at rock or shale level.

The fendering system, which incorporates cylindrical rubber buffers, has been designed to withstand the glancing blow of a vessel of 10,000 tons displacement berthing at 1-ft./sec. The fender piles are composite hewn greenheart and oregon pine members and the system is designed to facilitate the replacement of damaged piles or walings.

The wagon handling and coal shipping plant incorporates automatic marshalling gear and high-capacity rotary tipplers. The coal is carried by two belt conveyor systems to radial shipping towers sited at 150 feet centres.

## *Post-war Port Developments in the U.K.* – *continued*

Actual outputs attained have been 31,105 tons/week of eleven 8-hour shifts and 9,057 in two 8-hour shifts.

This project was completed in January 1954.

**No. 8 Dry Dock, Smith's Dock Co. Ltd., North Shields.**

In 1949 Smith's Dock Co. Ltd. foresaw the need for larger dry docks and after much consideration decided to provide a dock large enough to take a 38,000 ton d.w tanker with ample working space, requiring a dock 709 feet in length, 95 feet wide at the entrance, and having 27 feet of water at L.W.O.S.T. over the cill.

Owing to the existence of almost continuous boulder clay throughout the full depth of the excavation, it was possible to adopt steel sheet piling for permanently revetting the face of the dock below the subway construction level. The dock floor was designed to act as a simple beam spanning between the sheet-piled walls. It is reinforced with high-tensile steel bars in the top only. The sheet piling is secured to the floor by means of broad-flanged beam sections welded to the piles within the floor thickness. Allowance was made for external hydrostatic pressure up to mean tide level, the thickness varying between 12 feet at the entrance to 8 feet on the centre line at the dock head. There are no pressure-relieving ducts in the floor.

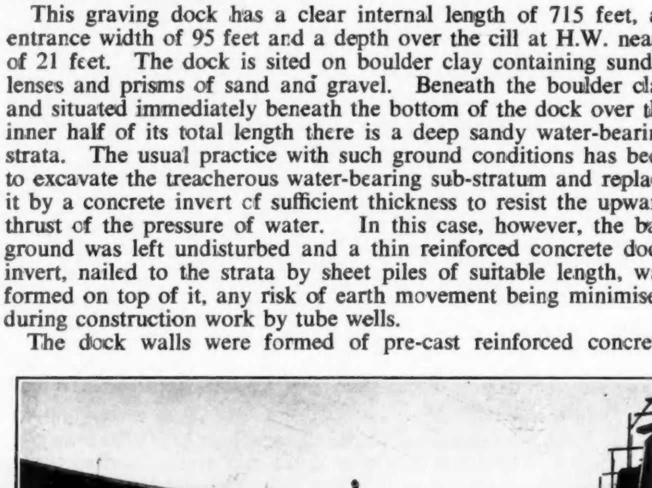
The main pumping plant is of the anti-siphonic type and is capable of de-watering the dock of $1\frac{3}{4}$ million cubic feet of water in $2\frac{1}{2}$ hours under the maximum head conditions. The box-type gate is 99 feet 2 inches long, 32 feet 8 inches deep and 7 feet wide, and weighs about 190 tons.

The dock is equipped with three cranes, plating and fitting shops and the usual ship-repairing services.

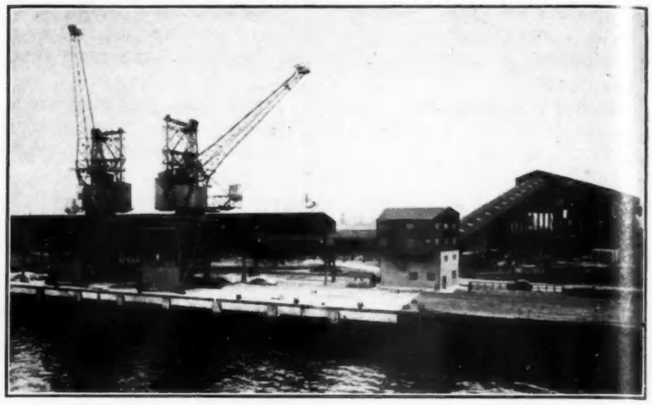
**New Dock for Brigham and Cowan, Ltd., South Shields.**

This graving dock has a clear internal length of 715 feet, an entrance width of 95 feet and a depth over the cill at H.W. neaps of 21 feet. The dock is sited on boulder clay containing sundry lenses and prisms of sand and gravel. Beneath the boulder clay and situated immediately beneath the bottom of the dock over the inner half of its total length there is a deep sandy water-bearing strata. The usual practice with such ground conditions has been to excavate the treacherous water-bearing sub-stratum and replace it by a concrete invert of sufficient thickness to resist the upward thrust of the pressure of water. In this case, however, the bad ground was left undisturbed and a thin reinforced concrete dock invert, nailed to the strata by sheet piles of suitable length, was formed on top of it, any risk of earth movement being minimised during construction work by tube wells.

The dock walls were formed of pre-cast reinforced concrete cantilevered ribs or buttresses supporting in-situ concrete slabbing 2 feet thick, the face of the boulder clay being left unsupported during the whole of the construction. The box-type gate is 99-ft. 6-in. long, 30-ft. 2-in. deep and 7-ft. 2-in. wide. Small hydraulic rams are provided to give the gate an initial thrust when opening on a rising tide.



View of Dock Floor of new Brigham & Cowan dock in course of construction. Some of the pre-cast ribs, weighing about 10 tons each, are to be seen lying in the foreground. Other ribs are seen standing erected on both sides.



General View of Iron Ore Quay, Tyne Dock.

**No. 4 Dry Dock, Swan, Hunter and Wigham Richardson, Ltd.**

This dock which was opened on May 14th of this year, is 715 feet long, 105 feet wide at the entrance, and 29 feet deep over the cill at H.W.O.S.T. It is capable of taking vessels up to 45,000 tons d.w. Owing to the very varied strata with layers of soft clays, silt and sands, it was decided to adopt the more traditional type of mass concrete wall. A point of interest is that high-tensile steel reinforcement was used in the back face of the walls to permit consolidated back-fill in place of concrete over the heel. The walls were concreted in 55-ft. lengths, with intermediate 5-ft. contraction gaps completed at a later stage.

The dock floor is designed to act as an inverted arch under hydrostatic pressure and is 14 feet thick at the centre and 10 feet at the sides where it is keyed to the side walls by a "bird's mouth" joint.

Equipment comprises a services subway, bollards and capstans, dockside cranes up to 50 tons capacity, telescopic shores and platers' and trades' sheds. The box-type gate is 111 feet 4 inches long by 35 feet deep and incorporates a mild steel billet as a meeting face bearing on quoins and cill of precast granite concrete. A rubber insert in the steel billet ensures complete watertightness.

**Other Works of Interest.**

The Tyne Tanker Cleaning Co. Ltd. has recently completed the construction of a cleaning station at Northumberland Dock comprising continuous facilities for the reception and treatment of contaminated ballast, tank washings and oily sludge and the gas-freeing of tankers. The Tyne Improvement Commission has provided a deep water berth of novel construction adjoining the installation where the vessels' berthing energy is absorbed by heavy cylindrical rubber buffers.

Mention should also be made of the cathodic protection installation to steel sheet toe piling at the Tyne Commission Quay, Albert Edward Dock. This installation, now embodying graphite anodes, has been in operation for five years and, so far as is known, is the original full-scale application by the impressed current system of cathodic protection to wharf structures.

**Wharf Reconstruction at Londonderry.**

The Londonderry Harbour Board is reconstructing, in ferro-concrete, a further part of the Queen's Quay. The 400-ft. extension, downstream, has been completed and work on another 450-ft. of wharfage is in hand. The Northern Ireland Government is providing half the estimated cost of £110,000.

*Post-war Port Developments in the U.K.—continued*

# The Port of Bristol

In the course of the last ten years the trade of the Port of Bristol has increased by 75 per cent. In 1947, by which time the war-time fluctuations had ceased, about four million tons of goods were handled. Now the total tonnage handled annually is over seven million.

Physical expansion of the ocean docks at Avonmouth reached its limit by the end of the war; nevertheless, by engaging in a progressive policy, the Port Authority has been able to deal with the greatly increased demands by improving certain berths, erecting new buildings and introducing more mechanical equipment of the most up-to-date nature. At the same time the secondary services, such as conservancy, lighting and communications, which are equally essential to efficiency, have been the subject of a great deal of study and improvement.

**New Berths and Wharf Lay-outs.**

The greatly increased export of general cargo from Britain has been reflected in the Port of Bristol, and at Avonmouth Docks two berths have been re-equipped for this traffic. Work on "T" Berth was completed in 1953, with the installation of five new 3-ton and two 10-ton cranes, the renewal of the six railway tracks and the improvement of access for road vehicles. At "X" berth an area of 1¼ acres has been levelled and concreted for the assembly of cars and the stacking of other export cargo. This year a record shipment from this country of 1,279 cars left this berth for the Pacific coast of North America.

Provision for the greatly increased trade in refined petroleum has been made by constructing 355-ft. of wharfage to form an additional berth for the coastal trade, and further ocean tanker berthage is now comtemplated.

The open West Wharf has been given a completely new lay-out, work on which has recently been completed. The aerial ropeway terminal was first moved to West Wharf 1, its construction and operation much improved, and five new 5-ton grabbing cranes provided for the discharge of bulk cargoes of ores and fertilisers. This left the rest of the area free for development as a timber-stacking ground with a new rail plan and a circular roadway.

**New Buildings.**

At the southern end of the West Wharf stacking ground, a Timber shed has been provided with a capacity of 1,000 standards. This building is of open steel-frame construction and in character typical of a number of single-storey buildings which have been erected at Avonmouth Docks in the last ten years, including a 10,000 ton general cargo warehouse, a 4,000 ton warehouse at present used for the storage of tea, and a 750-ft. long rail-to-road transfer shed for the animal feeding-stuffs trade. These buildings will be more easily adaptable than more massive concrete constructions for any changed needs in the future, and if, ultimately, demolition is required, they will have some scrap value. In the case of the rail-to-road transfer shed actual removal to another part of the docks is contemplated on the completion of a reclamation scheme behind "R," "Q" and "S" sheds.

Underneath the general cargo warehouse "E," there is a new semi-basement wet bond, built of concrete with a flat beam ceiling. It is equipped with strip lighting and barrel hoists and has a capacity of 8,000 hogsheads.

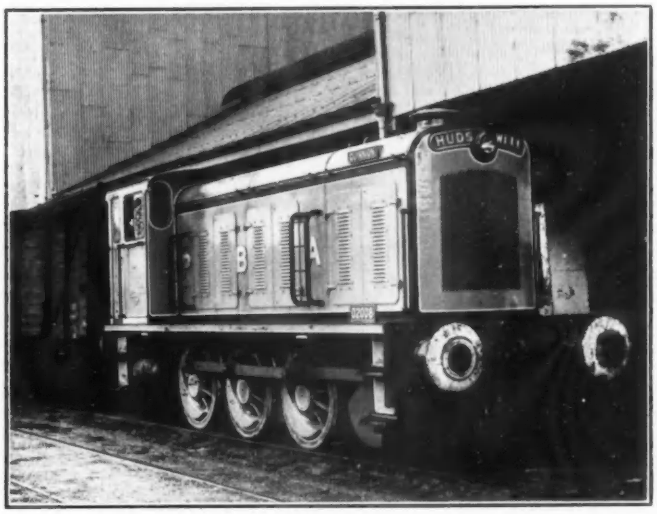
In the City Docks, which deal with the coastal and short-sea trades, a steel-frame warehouse was brought into use last year for the Dublin stout trade. Adjacent to this site at Prince's Wharf, the destruction by bombing of a large flour granary gave the opportunity for the erection of twin double-storey general cargo transit sheds of brick and steel-frame construction. They have a total floor space of 6,650 sq. yds. and are provided with four 2-ton electric hoists for delivery to road and rail at the rear from the first floor. On the quay outside there are four modern 2-ton and three 3-ton electric cranes.

**Mechanical Handling.**

Cranes have been established as a form of mechanical handling in the Port since the seventeenth century. In 1953 twenty 3-ton and three 10-ton electric wharf cranes were installed at "Q," "R," "S" and "T" berths at Avonmouth. They are level luffing cranes working on A.C. and incorporate the features most needed for dock work—high operational speeds with as large a number of cycles per hour as possible, a long enough jib to cover the shore area, a good view from the driver's cabin and simple maintenance. The standard 3-ton cranes have a hoisting speed of 240-ft. per minute and a controlled lowering speed of 400-ft. per minute.

Other forms of mechanical handling such as bag-piling elevators and runabout trucks have been in use in the Port for about a quarter of a century, much longer than one might suppose. But there is no doubt that the greatest development in this field has taken place in the last decade, particularly in the introduction of the fork-lift trucks and its variants, which are used for lifting pallets, casks, and slotted containers of liquid, stacking ingots, tea chests and wine casks, and moving steel coils in holds. The Port Authority has a large fleet of these vehicles in operation and the relative advantages of battery electric and internal combustion engine power has been closely studied, giving a balance at present in favour of the former.

For much heavier handling tasks in the sheds and on the quays, mobile cranes have been introduced. Tracked diesel versions are used for heavy timber, although for this commodity the straddle carrier, with a capacity of 6½ tons, is undoubtedly the most striking innovation.



One of the new 200 B.H.P. Diesel Locomotives.

**Railway Developments.**

One of the most important links in cargo handling operations is the Port's internal railway system which carries main line railway stock to and from the exchange sidings and the Port Authority's own stock of 1,400 open wagons and 205 bulk grain vans. Haulage is carried out by the Port Authority's locomotive fleet, which is undergoing a change to diesel power. There are now 14 diesel locomotives ranging up to 300 b.h.p. Their fuel range is greater than that of the old steam saddle tank engines, no time is wasted in raising steam, fire risk is diminished, and their higher overall efficiency with decreased costs is now being recognised by other ports. A very considerable saving in shunting costs is also made by the use where practicable of shunting tractors and electric capstans. At the same time the permanent way throughout the dock estate has received attention and at present an extensive five year plan of re-laying and reconstruction is half completed.

A small number of road vehicles is also used for the internal movement of cargo. Diesel lorries have been introduced which can carry either bulk grain containers or palletised cargo.

**Conservancy.**

One of the Port Authority's heaviest responsibilities lies in the provision of safe approaches and berths for shipping. An up-to-

*Post-war Port Developments in the U.K.—continued*

Cars awaiting export at "X" berth, Avonmouth Docks.

date 52-ft. diesel-engined launch fitted with an echo sounder carries out regular and extensive hydrographic surveys, and a dredging flotilla carries out the necessary improvement work indicated. Until recently dredging operations were carried out by a number of units which, owing to sound design and proved construction, had been in use for half a century and more, but they have now been replaced by new main units consisting of the dumb bucket dredger "Evenlode" and the diesel hopper "Kingroad," the dumb bucket dredger "Samuel Plimsoll" and attendant diesel hoppers "Frome" and "Avon." The latter trio were built at Bristol and work mainly in the City Docks.

**Electricity and Electronics.**

New signal stations have been built on the banks of the River Avon and together with all the sea-going units of the Port fleet are equipped with VHF radio.

Communications on shore have been subject to improvements recently completed. The emergency telephone and ship-to-shore telephone services, now extended to all the principal berths, have been centralised on the Police Control Room and the Port Authority's offices have been given a new private branch exchange. A special telephone system has also been introduced along the 300 yard length of the Royal Edward Dock entrance lock for the use of the berthing staff. Sodium vapour floodlighting has also been provided here, at the graving dock, "X" berth and other large open spaces. Mercury vapour lamps and certified flame-proof equipment are used in the Oil Basin. For cargo working, conventional tungsten lamps continue, for a number of reasons, to hold their own as the most suitable light source.

**The Trends of Future Development.**

It is in such work as that outlined immediately above and in the constant detailed study of cargo handling and mechanical efficiency that the Port Authority can look forward to a very profitable field of development in the future. Much of the large scale development undertaken since 1947 only came to fruition in the period 1950-55 for various familiar economic reasons. During the last year and a half, restrictions on capital expenditure have again slowed down the progress of large scale projects, and when considering an expansion of the whole dock system, it must be remembered that in theory it would be more economical to apply a system of shift working to the existing facilities. Nevertheless, alternative plans for new docks are kept under constant review and there is no doubt that, should they be deemed necessary at any future date, the Port of Bristol will undertake their construction.

## The Port of Liverpool

The Port of Liverpool dock estate covers an area of 2,037 acres, a water area of 638 acres and a lineal quayage of 36 miles. By the end of the war the docks had suffered the loss, through aerial bombardment, of 91 acres of transit sheds and warehouses completely destroyed and another 90 acres seriously damaged. Just over 100 acres of cargo accommodation were either untouched or suffered minor damage and, in addition, immense loss and damage was caused to cranes and other cargo handling appliances. Work on reconstruction and replacement commenced in November, 1946.

**Transit Sheds.**

The first new transit shed to be brought into commission after the war was built at the west side of the Alexandra Dock. The building is 1,600-ft. long of which 1,000-ft. is of double storey construction and 600-ft. single storey. The overall width of the site available was at one point only 191-ft. In order to leave a rail track and a roadway, a minimum of 60-ft. 6-in. wide, the width of the shed has had to be reduced to 110-ft. and the quay margin to 20-ft. 6-in. Owing to the sharp turn on the bridge over the passages at the north and south ends of the shed, it was not possible to provide railway lines on the quayside but the shed was equipped with 8 three-ton and 7 five-ton semi-portal quay cranes and 12 one-ton semi-portal travelling transporters on the roadside of the double storey portion.

The new shed on the north side of the Canada Branch Dock No. 1 is another example of the way in which restricted space can be utilised to the best advantage. The site is backed by a Graving Dock and in order to obtain a shed width of 120-ft. the quay margin was restricted to 12-ft. and 10 three-ton cranes provided on the roof.

These are but two examples of the many new transit sheds brought into commission during the post-war years. Together they cover sixty acres of floor space and give berthage for 23 deep sea vessels. In addition to the work of new construction, the rebuilding of partially demolished or damaged sheds has also involved major engineering operations. They range from the complete rebuilding of about 500-ft. of a reinforced concrete treble storey shed at the Gladstone Docks to the replacement of 2,460 heavy timber or steel shed doors, each measuring up to 275 square ft. together with their slide rails and runners.

**Bulk Cargo Facilities.**

The new developments at Liverpool have not been confined to the provision of accommodation for general cargoes only. The facilities for discharging bulk cargoes have also been augmented. In August, 1952, discharge commenced on a cargo consisting of 4,000 tons of unrefined Jamaican sugar, the first cargo of bulk sugar to arrive at the port. The quay at the north side of the Huskisson Branch Dock No. 3 was specially equipped to handle this type of cargo and the installation marked the first phase of a scheme of long term development by Messrs. Tate and Lyle Ltd. who leased the quay space from the Board. Grabs, each of 2½-tons capacity, working from 4 six-ton cranes discharge the bulk sugar into overheal mobile hoppers installed on the quayside behind the cranes. Each hopper holds 25 tons of sugar and can discharge into trailer mounted containers for transport to the refinery.

Since the first cargo was discharged the proportion of sugar shipped in bulk has increased enormously and the second phase of the development scheme, designed gradually to reduce cost and the time of ship turn-round, is almost complete. The sugar, when grabbed from the ship, will be discharged onto a conveyor belt and transported to a weigh tower on the back land. This tower will contain four weighing machines and, after weighing, the sugar can be delivered to road vehicles for transport to the refinery or to the adjacent silo, 90-ft. high and 543-ft. long. The silo will have a capacity of 100,000 tons. Apart from the obvious advantage of speedier handling the installation will obviate the necessity of maintaining a large fleet of road transport vehicles, which would only be employed part time.

When John Summers and Sons, Ltd. erected a new blast furnace plant at Shotton, Flintshire, an improvement in the equipment for handling iron ore at the dockside became necessary. A quay, 1,000-ft. long at the north side, Bidston Dock was adapted to deal

## *Post-war Port Developments in the U.K.—continued*

with the additional quantities of ore the firm now requires. Three 13-ton, electrically operated travelling grabbing transporters have been installed, each with a capacity of 350-tons per hour. The ore is discharged into hoppers on the transporter structure for delivery to rail wagons or into stockpile at the back of the quay. Marshalling sidings with weighing facilities and standage for the equivalent of 171 wagons of 65-tons capacity have also been provided. Two ships of 8,000-tons to 10,000-tons deadweight capacity can berth alongside at the same time and during the year ended June 30th last over 1,270,000 tons of ore were discharged at the quay.

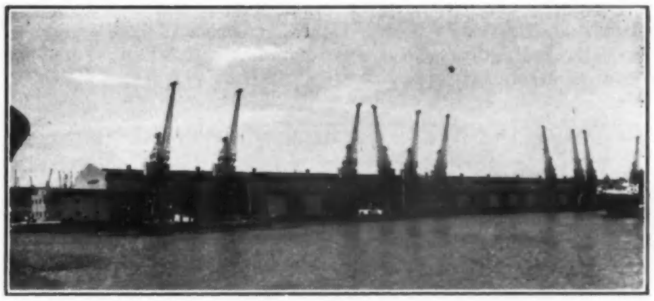
**Ship Repair Facilities.**

The first phase of a three stage programme for improving the ship repairing facilities on Merseyside is now nearing completion. It consists of the provision, at the Langton Graving Docks, of one electrically operated travelling crane with a capacity of 15-tons at 110-ft. maximum and 45-ft. minimum radius, which will enable the centre and the far side of the ship to be plumbed in both docks; the provision of a compressed air supply of 2,000 cubic ft. per minute, the air lines being fed from three compressors, and a salt water main fed from an electrically driven pump delivering a supply of 750 gallons per minute at 50 lbs. per sq. in. to supplement fresh water already available. At the Birkenhead Graving Docks, two cranes of similar design to that at the Langton Docks are being installed, together with a compressed air supply of 1,600 cubic ft. per minute, the air lines again being fed from three compressors. A salt water main, supplying 2,000 gallons per minute at 50 lbs. per sq. in., is also being provided. New electricity supplies have been laid on at both the Langton and Birkenhead Docks.

**Waterloo River Entrance Lock.**

As the time factor for the docking and undocking of vessels became more and more important one of the major post-war problems was the modernisation of some of the river entrances. The first work to be undertaken in this field was the completion of the Waterloo River Entrance Lock, serving the Central system of docks. These docks are used mainly by coastwise and cross channel vessels including those which maintain a regular service between Liverpool, Dublin and Belfast. The Board had, for many years, realised the need for improved docking facilities for these vessels and the construction of the new lock had been authorised as long ago as 1937. Work proceeded until the war and was then suspended until resumption became possible in 1945. The lock was opened officially in March, 1949. It is 450-ft. long and 65-ft. 6-in. wide and has three pairs of steel mitre gates with timber fendering and sealing faces. Each leaf weighs 175 tons and the sill, 17-ft. 6-in. below the level of low water equinoctial spring tides, will allow vessels to enter or leave the docks at practically any state of the tide.

100-ton capacity floating crane "Atlas."



View of new shed, North Side, Alexandra Branch Dock No. 3, Port of Liverpool.

**Langton Canada Improvements Scheme.**

The completion of the entrance enabled a start to be made on the Langton Canada Improvements Scheme, possibly the most ambitious dock reconstruction scheme to be undertaken in this country in recent years. From the time of the opening of the Langton and Canada Systems various improvements and extensions had been carried out to keep them in line with the ever increasing size and draught of shipping. In recent years, however, it had become clear that another deep water entrance was necessary so that ships could be docked and undocked for a substantial period of each tide. In addition, many of the sheds and quays were too narrow for modern cargo handling conditions and the controlling of the old, chain-operated timber gates of the Canada Lock was a difficult and hazardous operation in bad weather owing to their exposure to the north-west.

The main feature of the reconstruction is a new, deep water river entrance into the Langton Dock, 825-ft. long and 130-ft. wide, which will be provided with three, interchangeable, sliding caissons, each 113-ft. 6-in. long by 31-ft. 9-in. wide by 54-ft. deep, from top of plating to sill level. The side walls are of mass concrete founded on rock 65-ft. to 70-ft. below the coping, which is 9-ft. above the high water level of spring tides. The floor of the lock is of plain concrete 3-ft. thick vented with vertical drain pipes to obviate upthrust from the water-bearing substratum. The part of the lock which occupies the site of Canada Basin will be constructed in the open after the whole basin has been dammed from the river. There will be a minimum depth at low water springs of 19-ft. and a maximum depth at high water springs of 50-ft. This will allow the largest vessels using the port to pass through into the adjoining docks and enable foreign going vessels of average size to lock in and out eight hours each tide.

The existing passage between the present Langton and Brocklebank docks will be demolished and the passage between the Canada and Brocklebank docks is being completely rebuilt with a width of 130-ft. (to correspond with the entrance) as compared with the former 80-ft., and a sill level to give 40-ft. of water. The water level is maintained at the level of high water of the ordinary spring tides by pumping, and a new station for this purpose is included in the scheme. This is in order to compensate for any extra water lost due to the operation of the new lock at lower states of the tide than was possible with the old entrances and to make it possible to extend pump impounding to the Gladstone system of docks if required. The quay on the west side of the Canada Dock is being widened on both river and dock sides and considerably lengthened. A double storey transit shed is being constructed, equipped with electric cranes and railway lines and one section of this is now in commission. A further double storey transit shed is also being built on the west quay of the Langton Dock and the quay itself is being widened. A single storey transit shed will be erected on the new quay at the west side of the Brocklebank Dock. Modern transit shed accommodation will then be available for seven cargo liners.

**Lighting.**

Considerable improvements have been carried out to the general lighting of the dock estate. Advantage has been taken of the new technical developments in electric lighting and pre-war standards

## *Post-war Port Developments in the U.K.—continued*

have generally been replaced by modern installations. The scheme covers practically the whole of the estate area and ranges from the complete elimination of the few remaining gas lamps to the provision of completely new electrical transformer stations and installations.

**Conservancy.**

Apart from all these works, which are directly related to the handling of cargo or the movement of shipping in, or adjacent to, the dock system, the Dock Board are also responsible for the Conservancy work of the port. During the war the Board's fleet of vessels used for this branch of the port's activities, suffered badly through lack of refitting and replacement. Since the end of hostilities, however, the fleet has been augmented by the building of two pilot boats, two salvage and Conservancy vessels, three grab hopper dredgers, one bucket ladder dredger, a survey tender, a survey launch and a tug. Two more grab dredgers, a stone carrying hopper and a new pilot boat are at present under construction. In addition to these vessels, two new floating cranes, the "Titan" and the "Atlas" have been added to the Board's fleet.

**Radio and Radar.**

The development of ship to shore communications and port radar has been one of the most spectacular of the post war developments. A high frequency radio-telephone system was adopted to handle the serious war-time shipping congestion and this method of communication proved so valuable that it was decided to continue its use after the end of the war. After a few years' work the army sets originally in use became unserviceable and in 1950 a new V.H.F. communication system was installed.

The Port Radar Station was opened in 1948. The installation, with its six display units, provides a series of large scale pictures of the sea-channels and the river and enables a vessel to be supplied with minute-by-minute information about her position and course, and the positions of other vessels in her vicinity. Since the station was opened, 4,500 vessels have been assisted in this manner when entering port during low visibility. Since the original station was installed there have been many advances in radar technique, particularly in the degree of accuracy obtainable. Consequently the Board have recently placed a contract for new equipment which will provide an improvement in range and bearing discrimination and picture clarity, and will enable an even more efficient service to be given in future.

# The Port of Manchester

Since the completion of the Manchester Ship Canal in 1894, the Port of Manchester has grown steadily in importance and to-day it ranks third in the order of British ports with an annual traffic of over 18 million tons. It is also Great Britain's second oil port. Over the years, the increase in the port's trade has focussed attention on the necessity for an efficient turnround of shipping. While this aspect is important at every port, it is even more so at Manchester where, because of its inland position, delays can more easily cause congestion. The emphasis, therefore, has been on well-equipped berths with modern and adequate facilities. In this regard, a high level of efficiency in the mechanical handling of cargoes is essential, and during the second World War the Company's officials gave a close study to the employment of cargo handling aids for the future and the labour that would operate them. Consequently, at five of the main export loading berths pallet and container services are in operation.

After the war, in view of the increase timber imports which were expected, fundamental changes were effected in the timber handling technique used at the North No. 9 Dock and Salford Quay, which are the two main discharge points. The open quay at the former of these was asphalted for a length of nearly 2,000-ft. and a width of approximately 100-ft. A considerable addition was made to the quay stacking space by levelling out a substantial portion of underdeveloped land adjacent and parallel to the quay proper. Previously a full cargo of timber was stacked on the quay space proper, approximately within the limits of a ship's length and to a width of 100-ft. This development doubled the reception areas which, in turn, freed the quays.

As the handling to outer areas requires speedy methods of dispersal, Straddle Carriers, Ross Elevators, Fork Lift Trucks and other mobile equipment have been introduced. While mobile cranes, electric trucks, etc. could keep pace with the speed of ship discharge when working across the quay space proper, the new machines are swifter in moving timber from ship's side to the stacking point.

The direct ex-ship loading of timber to railway trucks alongside is carried out simultaneously with these operations. Open and uncongested conditions of working result from the general system of disposing to trucks and dispersing to areas away from the ship.

**Cranes.**

During the war years the port's development programme included provision for the installation of modern 3-ton luffing cranes to replace electric and hydraulic fixed jib type cranes, and a general scheme was put in hand for the electrification of the older sections of the docks operating under hydraulic power. This programme has continued, despite the difficulties experienced when berths had to be put out of commission for the necessary work on quays to be carried out. At Irwell Park Wharf, five $7\frac{1}{2}$-ton electric luffing grab cranes have been added to the five 5-ton level luffing electric grab cranes already in use for the discharge of bulk cargoes such as phosphates, ores, sulphur etc. The existing railway facilities were also extended and mechanical shovels for trimming to grabs have been introduced.

The $7\frac{1}{2}$-ton cranes of the level luffing type were supplied by Clyde Crane and Booth, Ltd. and, although designed primarily as grabbing cranes, they are also provided with a crane hook for ground cargo. The luffing gear is of the rack-operated type, with a swinging back mast to give a level path to the load. The advantage of this type is that only a single line of rope passes from the hoisting barrels over the jib-head pulleys. There is no doubling back, and consequently this arrangement is most suitable for multi-rope grab operation. The tail of the jib has a swinging back mast connected to it so that the arm moves outwards as the jib moves outwards, thus taking up the difference in rope length between minimum and maximum radius position.

Maximum radius of the cranes, $61\frac{1}{2}$-ft.; minimum radius, 18-ft.; rail centres 13-ft. 5-in.; hoisting, $7\frac{1}{2}$ tons at 250-ft. per min.; luffing, $7\frac{1}{2}$ tons at 120 f.p.m.; slewing, $7\frac{1}{2}$ tons at 1.5 r.p.m.; travelling, $7\frac{1}{2}$ tons at 75 f.p.m. Hoisting motion of the two-motor type operating four-rope Priestman grab. Electric motors H.P. and speeds:—Hoist, two 100 H.P. at 585 r.p.m.; luffing, one 15 H.P. at 720 r.p.m.; slewing, one 25 H.P. at 725 r.p.m.; travelling two 15 H.P. at 720 r.p.m. Consideration is being given to the provision of a further set of $7\frac{1}{2}$-ton cranes to replace the 5-ton cranes referred to earlier.

Control of all crane motions is carried out by means of small master controllers operating automatic contactor equipment. On the hoisting movement the contactor control is arranged to provide counter current braking on the lowering side of both hoist motors. The master controllers are combined into a controlled unit incorporated in a driver's seat.

The total number of cranes of this type installed by the Manchester Ship Canal Company since the second World War is 56. This number includes a recently completed installation of 12 electric cargo cranes, manufactured by Stothert and Pitt Ltd. These cranes are designed to lift 3 tons at a maximum radius of 45-ft. and have a 67-ft. height of lift above the level of the wharf.

They are of the crank luffing type with a 55 b.h.p. electric motor driving the hoist barrel through a totally enclosed worm gear running in oil; this ensures a silent and high efficiency drive. The barrel rotates on a fixed shaft so that no torsional or reversing stresses occur in the shaft. Rated speed of hoist with three tons load is 200-ft. per minute, and the motor is series controlled for hoisting, while lowering is dynamically braked on the potentiometer system.

Of cantilever construction, the jib is balanced by weights carried in jib tails at either side of the machinery house. This ensures equilibrium at any radius whatever the load. The luffing motion is imparted to the jib by means of cranks and connecting rods and

*Post-war Port Developments in the U.K.—continued*

View of timber dispersal areas, quay, roadway, rail and lighting facilities at North 9 Dock, Port of Manchester.

the variation of luffing speed is therefore harmonic, giving lower speeds at the maximum and minimum radius and higher speeds in the middle range. This greatly facilitates handling of the load. Owing to the relative position of the jib and apex pulleys, the load moves on a horizontal path when luffing. As a result, the luffing drive, which is through a worm box and spur gearing has only to overcome friction and wind resistance, so consumption of power for this motion is low.

A "live-ring" of conical steel rollers, running between tapered paths, supports the rotating superstructure of the crane, thus minimising friction by employing a true rolling action. The slew pinion, which meshes with a circular rack of steel pins, is actuated by a silent high-efficiency worm drive. The system is protected from shock loads by an adjustable slipping device and the accurate control of slewing is permitted by an internal expanding brake. This also locks the superstructure when the crane is not in use.

The crane is mounted on four cast-steel travelling wheels. One pair is positively driven by a 12 b.h.p. motor through a totally-enclosed worm gear running in oil, and thence through spur gearing. As these cranes travel on a track of only 4-ft. 8½-in. gauge, outrigger girders and screw jacks are necessary to give the required stability when working. These increase the base width to 9-ft. 6¼-in. Travel control is operated from ground level and an interlock switch ensures that the other motions cannot be used whilst the crane is travelling.

A number of electric dock trucks incorporating an elevating platform are in use at Manchester. The elevating platform of these trucks, which are manufactured by Wingrove and Rodgers, Ltd., enables the handling of loads on stillages.

A public address system has recently been installed which allows the whole of the docks estate to be alerted at the turn of a switch. This system is supplementary to the telephone link-up which connects all points on the docks.

**High Frequency Radio Telephony.**

Between Eastham and the Manchester Docks ships must pass through five lock systems and nine swing bridges and there are nine points where ships cannot pass each other. Thus rigorous control must be imposed on all shipping movements.

Since the installation of a high frequency radio telephone network the working of ships along the 35½ miles of canal has been greatly facilitated.

This system, operated in connection with the land line telephones between the dock offices at Manchester and the major bridge and lock installations, provides regular up to the minute information to the Harbour Master's office where the position and progress of every ship on the canal is plotted on a chart. Most of the Ship Canal Company's fleet of tugs are equipped with radio telephone equipment and are able to communicate details of position and speed to one of three control rooms.

The system has become an integral part of canal communication. It has been found that waiting time is reduced, traffic is kept moving smoothly and movement orders are speedily and confidently transmitted.

**The New Eastham Dock.**

One aspect of the port's growth since the war deserves particular mention and that is the new Queen Elizabeth II Dock at Eastham, which was officially open on January 19th, 1954. This dock, the largest of its kind in Great Britain, covers 19 acres in the form of a square, and is the Canal Company's contribution to the country's post-war policy of refining oil in Great Britain.

The Eastham Dock is placed strategically at the head of the Mersey Tideway and is close to the many refineries and oil tank farms in the Stanlow area. It contains four berths and has a depth of 40-ft. The floor of the dock is natural sandstone while the walls are of concrete. Culverts connect the basin to the Ship Canal in order to maintain the water level without pumping.

The dimensions of the berths are as follows: No. 1 Berth 800-ft.; No. 2 Berth 725-ft.; No. 3 Berth 900-ft.; No. 4 Berth 730-ft. Each is capable of accommodating a super-tanker. Berths 2, 3 and 4 are equipped with Company's pipelines. All the berths are equipped with ship to shore telephones connecting direct into the Ship Canal Company's dial system, a 12-in. ring main for fire-fighting, a 9-in. fresh water main and a 11,000 volt electricity supply. There are also foam units at each berth and the dock is permanently connected by telephone to the nearest fire brigades in Cheshire.

Apart from the conventional safety precautions mentioned above, special precautions, the first of their kind in the world, have been taken to deal with spilt oil. The device consists of "oil weirs" which are grills set in the four corners of the dock area at surface level.

Three of the berths have been equipped with facilities for unloading oil. The oil pipes are carried to the dockside on gantries; on each gantry there are two cranes for handling the flexible hoses which form the link between ship and pipeline. By this means, not less than four hose connections to each tanker can be made in a short time.

Special attention was given to the provision of adequate lighting both at the lock and at the berths. The general lighting of the lock and dockside is by 250-watt blown cut-off lanterns mounted on 25-ft. columns. Where more powerful lighting is needed at positions where the pipeline connections are handled and linked with the tankers, 400-watt mercury floodlights have been mounted on 40-ft. columns.

The entrance lock gates comprise three sliding caissons, each of all-welded steel construction, displacing some 1,700 tons with a length of 106-ft., a width of 23-ft. and a depth of 57-ft. They are built to withstand a total water pressure of approximately 5,000 tons, which acts on the caisson when dry on one side. The caissons are divided horizontally by watertight decks into three parts. The top section, open at both ends, is a tidal waterway; the centre section houses an air chamber, two scuttle tanks and four trim tanks; the lower section is a ballast chamber. "VSG" variable delivery pumps and motors are used to control the movements of the caissons which, because of their very great inertia, must have precise and sensitive control.

*Post-war Port Developments in the U.K.—continued*

# The Port of Glasgow

The Clyde Navigation Trustees have carried out or are in process of carrying out the following new construction works in Glasgow Harbour since the end of the war.

**Shieldhall Riverside Quay—Extension Eastwards.**

To provide deep water berthage and facilities for timber and mineral discharge, Shieldhall Riverside Quay was extended eastwards for a length of 918 feet to give a dredged depth of 32 feet at L.W.O.S.T. The work entailed the demolition of 650 lineal feet of the existing Shieldhall Timber Wharf, the widening of the river by 80 feet alongside the new quay and the paving in concrete of the existing Shieldhall Timber Yard (approximately 10 acres).

The new quay wall is founded on 30 feet square monoliths, constructed of pre-cast concrete blocks built in courses 2 feet deep, each monolith having a steel shoe and cutting edge and four 10 feet square wells to permit the digging to be carried out. The monoliths were sunk through sand and sandy clay from an open trench excavated to a level of −6 O.D. the trench being de-watered by well pointing, the rate of sinking varying from one to eight feet per day. The front wells were filled with foam slag concrete and the rear wells with heavy slag concrete. The 4 feet wide spaces between the monoliths were sealed with steel sheet piling, excavated and filled with concrete. A steel sheet piled cofferdam had to be constructed at the junction of the new wall with the existing wall to seal the trench.

The superstructure was formed in mass concrete from −6 O.D. to cope level +14.6 O.D., a service tunnel being incorporated in the superstructure.

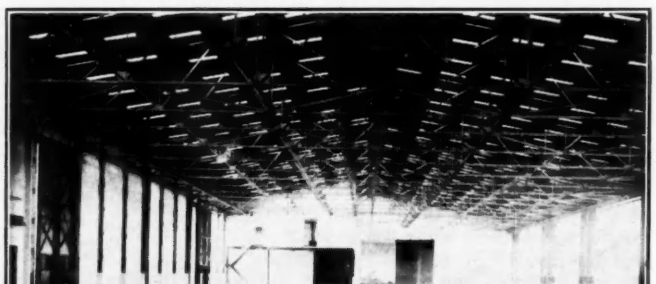
A crane track for 10 ton electric travelling portal cranes has been provided on the quay and the rail facilities for handling the timber and mineral discharge include five lines of rails together with weighing machine facilities and electric capstans. The quay breast and the Shieldhall Timber Yard immediately behind the quay have been paved in concrete to make the whole area suitable for the rapid unloading of timber by means of Ross Carriers and Stackers.

Between the east end of the new quay wall and the existing Shieldhall Wharf, a permanent steel sheet piled breast work has been constructed.

The quay will be provided with three 6-ton and two 10-ton electric travelling cranes.

**King George V Dock, West Quay—Single Storey Shed.**

In order to meet the requirements of post-war trade, the Trustees authorised the construction of a single-storey goods shed at Berths 7 and 8, King George V Dock. The shed, which is a steel framed structure with a back wall of reinforced brickwork, was completed and brought into use in 1951. It is divided by a firewall into two equal lengths of 480 feet and has a clear span of 120 feet. Along the front of the shed and adjacent to the 45 feet wide quay breast are continuous sliding doors running on rails at quay level. A double line of railway track runs through each of the two portions of the shed at such an angle that it was necessary to spread the column centres to 48 feet, an increase of some 16 feet over the normal in the harbour. This column spacing, coupled with the fact that the development of the use of mobile cranes had made it necessary to preserve a minimum clear headroom of 25 feet, resulted in individual doors being 24 feet 6 inches wide and 25 feet high. The normal shed door up to this time had been some 16 feet 6 inches wide by 15 feet high and this permitted doors to be constructed in timber, which had the advantage of easy replacement of damaged sections. As the timber doors weighed about one ton, they could be moved by hand with reasonable effort. The increase in size made timber construction impracticable and it was decided to adopt doors of a robust construction using steel framing and plating. Each door weighs about 5 tons and two sets of hand-operated gearing are incorporated in each so that any door may be moved by one man, irrespective of its position relative to other doors or to shed columns. Two experimental doors were constructed in aluminium alloy sections and plates. The aluminium doors are designed to give the same strength as the steel doors and their weight is half that of the steel doors.



New Shed at King George V Dock, West Quay, Port of Glasgow.

Shieldhall Riverside Quay. Monolith Sinking in progress.

The shed roof, which has a flat pitch of some 10°, is of protected metal with rooflights which cover 5% of the floor area.

In construction of the shed floor, a departure was made from the usual practice of laying whinstone setts on a concrete raft. A more economical floor was provided by laying a two inch thick wearing course of high quality concrete with a granite aggregate on a seven inch thick concrete base course. The floor was laid in panels and the concrete vibrated.

**General Terminus Quay—Ore Handling Scheme.**

Messrs. Colvilles' new steel works at Ravenscraig, together with their present Clyde Iron Works, will require an intake of well over 1,000,000 tons of iron ore per annum, rising much higher when the scheme is in full operation. With this in view, General Terminus Quay has had to be adapted.

Three very large transporters for unloading the ore and conveyor bands for transporting the ore to rail wagons have been erected on the quay and this has necessitated the strengthening of the quay wall, the work having been in progress during the past years. Each transporter will be capable of unloading at the rate of 600 tons per hour, using 20-ton grabs, which will lift 10 tons of ore per cycle. The transporters will be capable of dealing simultaneously with two ships of up to 16,000 tons with an approximate length of 530 feet.

The ore will be discharged direct through hoppers on the transporters to two conveyor bands each of 1,000 tons per hour capacity, running underneath the transporters. These will convey the ore to large hoppers capable of loading direct into 45-ton bottom discharging rail wagons which have been specially constructed by British Railways for this purpose.

Two trains each carrying about 900 tons of ore can be loaded simultaneously and when running a shuttle service between the

*Post-war Port Developments in the U.K.—continued*

quay and the works are capable of conveying 14,000 tons of ore every 24 hours.

As the loading from the transporters on the front of the quay wall amounts to 410 tons on two 8-wheeled bogies, the quay wall had to be strengthened and this has been done by the placing of 4-in. diameter high tensile steel tie-rods which are designed to take loads of 100 tons each, anchored to a heavy beam supported on vertical and raking piles at the back of the quay wall which also carries the back rail for the transporters. In order to prevent forward movement of the wall under the transporter loads, the tie-rods have been pre-stressed to 50 tons each by jacking.

The work on the quay wall is practically completed. The transporters are now in course of erection and the quay is expected to go into part operation about mid-July of this year.

**Queen's Dock—Modernisation.**

A large scheme of modernisation is being carried out at Queen's Dock, involving the re-roofing of sheds and their equipment with modern lighting and the provision on the quays of 24 3-ton cranes to facilitate cargo handling.

About one-third of the quays have been dealt with and four cranes are already in operation. Work on the other quays is proceeding.

In addition to the above works which are either completed or nearing completion, the major schemes on which work has been commenced are:

(1) **Meadowside Quay—New Grain Silo.**

A new 50,000-ton grain silo together with six quay wall 2-nozzle pneumatic elevators with an output of 1,200 tons of grain per hour and four conveyor bands, carried in an overhead gantry, serving three berths, each conveyor band having a capacity of 400 tons per hour.

Provision will also be made for loading out to vessels either bulk or sacked grain.

(2) **Broomielaw Quay.**

A new storage shed and Passenger Terminal is being built for the use of the Burns and Laird Lines' vessels on the Glasgow-Belfast daily service.

# The Port of Dover

On the cessation of hostilities in 1945, the Dover Harbour Board, in Common with ~~most Port Authorities~~, were faced with a formidable task of rehabilitation. Not only had the very considerable war damage to be made good, but a backlog of maintenance work, necessarily deferred due to war conditions generally and on account of inaccessibility of certain areas in Government occupation, had to be overhauled in order to bring the port installations back to commercial standards and requirements. The damage caused by enemy action alone amounted to £500,000. In addition, the deferred maintenance programme included a great deal of work on sea walls and groynes which has been particularly heavy due to the enforced neglect over the war years.

### General Developments

Before describing the new car ferry terminal, which is the largest project undertaken by the Board since the war, a brief comment will be given of the more general work of rehabilitation and reconstruction. In tackling the situation, the policy followed has been to restore war damage in keeping with a co-ordinated plan for the development of Port facilities as required to meet the demands of post-war shipping, and in keeping with modern docks practice. In the Western Docks areas, in particular, advantage was taken to demolish a large number of obsolete and damaged dock-side buildings, many of which had little or no direct connection with Port working. The result has been the opening up of additional dock and quayside areas and their re-development for the extended use of trade. At the same time new rail and crane tracks were laid for the efficient transfer of cargo from ship to and from rail or road transport, whilst new electric cranes have been installed, warehouses modernised and a new transit shed is in course of erection.

In close conjunction with the Local Authority certain dockside public highways within the Port estate were closed and made dock roads, which has permitted the introduction of greater security measures in that the transit or cargo working areas have been completely enclosed by fencing and are now controlled by Docks Police at the docks entrance.

Other works to which particular attention has been given in the post-war period have been the re-design of the whole of the Eastern Docks lay-out; the re-planning and re-building of the workshops and stores areas of the Board; the erection at the Eastern Entrance to the Harbour of a new modern Port Control Signal Station, fitted with all the latest control devices; and the adaptation of new head office buildings. There have also been additions and other developments in the Port trading estate and the general estate.

During 1957 the new specially designed Tender "Delphinus" will come into service, which will afford much greater accommodation and comfort for the transportation of passengers and their baggage to and from ocean-going vessels calling at the Port and anchoring in the Outer Harbour. This vessel is at present being built to the specification of the Board, and to the design of Messrs. Burness, Corlett & Partners, Naval Architects, in the Appledore Yards of Messrs. P. K. Harris (Shipbuilders) Limited,

General view of portals and berths, Dover Car Ferry Terminal.

as are two new Harbour Tugs "Diligent" and "Dominant." These twin-screw diesel Tugs of hydroconic design, will each have a total of 1,040 H.P. and will replace the Tugs "Lady Brassey" and "Lady Duncannon" now approaching the end of their long and useful service at Dover and in the waters immediately adjacent.

During the ten immediate post-war years the expenditure by the Board on maintenance has totalled £1,330,000, and during the same period Capital Expenditure has amounted to £1,250,000. About two-thirds of the latter was incurred in the erection of the Car Ferry Terminal installation in the Eastern Docks, dealt with in detail below.

**Car Ferry Terminal.**

By virtue of its unique geographical position in relation to the Continent, Dover has always been important to Cross Channel traffic in passengers, goods and accompanied motor cars. The passage of accompanied cars and coaches to the Continent through Dover has greatly increased since 1928 when two specially adapted vessels were placed on the service for handling accompanied cars and coaches to and from the Continent.

Between 1928 and the outbreak of war in 1939, the number of vehicles passing through Dover steadily increased from 6,000 to 31,000 per annum. After the war, the traffic again grew rapidly and now more than 200,000 vehicles are handled every year. Before the war, all vehicles for the special Car Ferries were loaded by crane and it was quickly realised that, in view of the rapid increase in traffic, loading facilities must be improved. The

## *Post-war Port Developments in the U.K.—continued*

provision of better facilities was prevented by the outbreak of hostilities. After the war, modern, fast and well-appointed car-carrying Ferries were brought into service by all the Operators and stern loading doors were fitted in anticipation of the provision of loading bridges to allow direct discharges on and off the vessels at both sides of the Channel.

In the early post-war years, design work was recommenced and plans were completed in readiness for construction to be started as soon as Government permission to undertake capital works could be obtained. Sanction for construction of the new Terminal was given by the Government in February, 1951, and was actually one of the first granted in respect of maritime works. The Terminal was in full use by July, 1953, and the ancillary works were completed by the end of that year. The total cost of the Terminal was about £850,000.

**General Description of the Terminal.**

The Terminal was designed to handle all the traffic envisaged for several years and accommodation was provided for two vessels to load and discharge simultaneously at all states of the tide. At the present time the maximum number of vessels using the Terminal in any one period of 24 hours is four. The shore facilities, including large Car Parks, a Reception Building and covered Customs Examination accommodation, were specially designed to assist the speedy passage of cars through the necessary shore formalities.

**The Loading Berths.**

The two loading berths have depths of 21-ft. of water at low water, ordinary spring tides. Each berth is served by a loading bridge to enable vehicles to drive directly on board. The berths are each 400-ft. long and 72-ft. wide, and are designed to handle vessels of between 300-ft. and 400-ft. in length and between 35-ft. and 62-ft. breadth overall and a displacement of about 4,000 tons at load draught.

The berths were formed in the Camber at the Eastern Docks by widening the existing West Jetty by 10-ft. and constructing two additional jetties parallel to the West Jetty, thereby enclosing the two berths. The new jetties consist of a series of concrete dolphins formed by Appleby-Frodingham No. 2 section steel sheet piling, driven approximately 5-ft. into the chalk of the sea bed to form cofferdams, approximately 30-ft. square, which were filled with mass concrete, placed under water by tremie. Above the piling level the dolphins are constructed in mass concrete placed inside timber shuttering. The central jetty is composed of two isolated dolphins, whereas the eastern jetty is formed by three dolphins linked together by steel footbridges. The head dolphins to each jetty are approximately twice the size of the normal dolphins and are provided with a timber and rubber flexible fender system to prevent damage to shipping and dolphins during berthing operations. At the shore end of the berths five dolphins were constructed in a similar form to the berthing dolphins and upon these the reinforced concrete portal towers have been constructed.

In order to restrict the movement of the stern of the ship whilst loading is in progress, special attention was given to the design of the stern moorings and fendering. The fenders are intended to locate the stern of the ship in its correct position to allow road access to the Car Deck, to act as a flexible cushion to damp out the motion of the ship, and to act as a buffer for the vessel during the operation of berthing. They comprise a steel frame, faced with timbers for the bearing of the ship, and backed by a series of specially designed hydraulic buffers. The assembly hangs from chains from the jetty structure. Other chains restrict outward movement.

The loading berth adjacent to the West Jetty is served by a 4-ton electric crane for loading or discharging ships' stores, etc. Water, fuel oil, and electricity supplies (both direct and alternating current) are provided at all berths.

A reinforced concrete wall 20-ft. high and over 1,000-ft. long was constructed on the West Jetty to protect the berths and their approaches from the prevailing south-west wind.

**Loading Bridges and Ramps.**

Access from the shore to the Car Deck of the vessel is by means of a short ramp leading from the Car Park, along the loading bridge, and across a short link span. The bridges, which are each 140-ft. long, and weigh 235 tons, are hinged at the land end and are raised or lowered at the seaward end by means of hoisting machinery situated in the portals. The movement of each bridge is arranged so that it automatically follows the level of the deck of the ship as it varies with the tide or loading as described later. Vessels can be loaded at all normal states of the tide, and even in extreme tides loading can proceed provided the deck is between 6-ft. and 18-ft. 6-in. above water level.

The range of Ordinary Spring Tides is 18-ft. 9-in., but for the purpose of the design the overall range was taken as 22-ft. This means that the vertical movement of the bridges at the seaward end is 34-ft. 6-in. (i.e. cars can be loaded on to the lowest deck of the vessel at the lowest Low Water and on to the upper deck at the highest High Water). The bridges and accessory gear are suspended inside the portals and a large proportion of the dead load is balanced by two counterweights in the wings of each portal. The live load and excess dead load is carried by the main hoisting winch, which is situated in the machine room immediately over the bridge. The main control of each set of machinery is from a control desk inside the control building between the two portals. Hoisting and lowering can be carried out under manual control frim this desk and after the link span has been lowered on to the deck of the ship the automatic control gear can be brought into operation. The automatic limit switches are situated underneath the link span and are operated by the variations in angle of the span itself, and control is therefore regulated directly by the level of the ship's deck. The portal towers rise 87-ft. above Low Water level and are 108-ft. above the chalk foundation.

**Land Facilities.**

The land facilities were designed to allow the necessary traffic movements and the Customs and Immigration formalities to be accomplished as speedily as possible. To this end large Car Parks and a system of one-way roads were provided. A Reception Building and Customs Examination Hall, in addition to a 12-pump petrol filling station, were also constructed.

The Reception Building is a steel-framed structure clad in brick and concrete, with large windows in modern style. On the ground floor, overlooking the Reception Car Park, is the main Reception Hall where the traveller can obtain last minute information from the various Shipping Operators and Motoring Clubs. In addition, a Bank, Shop, Telephones, Postal facilities, Waiting and Cloak Rooms are available for the passenger. A feature of the Main Hall is a map of Europe on the wall at the south end. This map, which is 20-ft. high and 22-ft. wide, shows the main arterial routes across the Continent. Overlooking the Harbour is the fully licensed "Merry Dolphin" Restaurant which provides Buffet and Bar facilities. The upper floors of the building are devoted to office accommodation for the various Government Departments and other parties operating at the Terminal.

The Customs Examination Hall, with 42,000-ft. of covered accommodation, has been planned to handle 240 cars per hour. Car and baggage examination islands laid out in herring-bone fashion are provided to permit a constant flow of traffic without interruption. The building is constructed in two bays with galvanised steel roof trusses of 95-ft. span. The whole building is lighted at night with fluorescent lighting. Situated in a central position overlooking the whole Hall is a Control Room which contains public address equipment and automatic telephones communicating with all parts of the Terminal.

All roadways and car parks are illuminated at night by mercury vapour discharge lamps. Additional floodlighting is provided in the eastern car park from lamps fixed to the tops of tubular steel towers 50-ft. high.

**Ardrossan Tanker Berth.**

To meet the further requirements of the oil industry, the Ardrossan Harbour Company are enlarging the North Montgomerie pier tanker berth to accommodate tankers of 18,000 tons deadweight. The work, which was started early this year, involves dredging, rock removal and the construction of an additional jetty.

*Post-war Port Developments in the U.K.—continued*

## South Wales Docks

The British Transport Commission, the owners of the South Wales Docks of Newport, Cardiff, Barry, Port Talbot and Swansea, have, since they assumed control in 1948, pursued a progressive policy of modernisation of the facilities and equipment of these docks.

It was evident that, with the changing flow of traffic consequent upon the serious decline in coal shipments, special efforts were necessary to encourage an increase in the imports and exports of other traffic. With this end in view, the Commission embarked on a programme to bring the equipment and facilities of the docks up to a state of modern efficiency. Quite apart from maintenance Expenditure which, year by year, costs approximately £1½ to £2 million, an expenditure of nearly £5 million has been authorised for new works, etc., of various kinds. Some of the items included in this figure have already been completed; others are in varying stages of progress.

A brief description of these works at each of the ports is given below:

**Cardiff Docks.**

Schemes for the electrification of the Commission's Commercial Graving Dock and No. 1 Power Station have been approved at an estimated cost of £243,000, and the work on the Graving Dock, consisting of the replacement of steam pumping plant by two 42-in. diameter axial flow electrically-driven pumps, has been completed. The present steam-driven hydraulic and impounding pumps at No. 1 Power Station, Queen Alexandra Dock lock entrance, are to be replaced by six electrically-operated 42-in. axial flow impounding pumps, and three 800 gallons-per-minute and two 350 gallons-per-minute multi-stage turbine pressure pumps; this work is now proceeding.

To facilitate speedier housing and shipment of cargoes, a Jones K.L. 66 mobile crane and four Rosser trucks have been provided. Fork lift trucks are also available.

The Commission's mechanical and electrical engineers' workshops have been modernised, incorporating smith, welding and annealing shops, a wire shop and store, and a chain testing installation. The major maintenance jobs for all the South Wales Docks are now dealt with at these shops.

Messrs. Guest, Keen Iron and Steel Company, who have large works at Cardiff Docks, have recently modernised their iron ore wharf at Roath Dock by the provision of five 10-ton electric "Kangaroo" cranes. Other important improvements have been effected, both at the quayside and at their adjacent works.

Sludge tanks and oil separating plant have been constructed by the Mountstuart Dry Dock Company, and the firm's Bute dry docks at Cardiff has been widened to take larger vessels and their channel dry dock provided with improved workshop facilities, etc.

**Barry Docks.**

Barry Docks was designed primarily as a coal shipment port and the collapse in coal exports has had a serious effect on the trade of the port. To offset this loss, efforts have been made to introduce a more balanced activity and one of the general cargo berths was equipped as a discharging berth for imported coal, complete with coal screening plant. In 1955, new self-dumping and ring discharge grabs were purchased at a cost of £3,500, and last year four "Calfdozers" were introduced, at a cost of approximately £3,000, for use in the holds of vessels to speed up the discharge of bulk cargoes.

A scheme has recently beeen approved for a new bulk cargo discharging berth, which will be equipped with five 10-ton electric grabbing cranes at an estimated cost of £265,000. the anticipated date of completion being 1959/60. This berth, 570-ft. in length, will deal with bulk dry cargoes, such as imported coal, scrap iron and steel, ores and chemicals.

As a corollary to the efforts to develop other than coal shipment at Barry, the electrical distribution services are being improved and the Commission have decided to replace the existing 3.3 KV main by an 11 KV main and renew the H.T. and L.T. switchgear and transformers. Four new sub-stations will also be provided. The new installation will have a capacity of 6,000 KVA, which is considered adequate to meet the present and foreseeable needs of the port. The estimated cost of the scheme is £131,000.

The middle lock gates at the Lady Windsor Lock were recently renewed at a total cost of £82,000. The new gates are of the all-welded, rollerless steel type. The anchorages and pivots were also renewed and the gate operating machinery was overhauled, together with the dressing of the hollow quoins.

Considerable development in the fuel and edible oil trade has taken place at Barry, where the installations provided during the war by the Government have been taken over by Messrs. Cory Bros. and Co. Ltd. In addition, the firm are extending their activities and have taken over additional land on the South side of No. 1 Dock, Barry.

The Commercial Dry Dock, which is leased to Messrs. C. H. Bailey and Co. Ltd., has been widened and reconstructed, and an oil separating plant has been installed.

**Newport Docks.**

The iron and steel manufacturing trade has occupied a leading position in South Wales industry for many years and this is reflected at Newport Docks in the large tonnages of iron ore imported annually. In addition, appreciable import tonnages of other ores are dealt with at these docks.

Improved facilities for the rapid handling of these cargoes were provided in 1951 at the Middle Quay, South Dock, at a cost of approximately £120,000, by the installation of six electrically-operated level-luffing grabbing cranes of 10 tons capacity. This has resulted in a quicker turn-round of vessels, and greater efficiency in the handling of this traffic. To facilitate the operation of the berth, two 3-ton electrically-operated capstans were installed, together with adequate flood-lighting for shift working.

Six 10-ton electric cranes discharging iron ore at Newport Docks.

In 1956, the modernisation of another berth at the South Dock was undertaken, the aim being to provide two modern discharging berths for bulk discharge. Four new electric luffing grab cranes of 10 ton capacity, similar to those at the Middle Quay, have been ordered, and by the transfer of one of the 10-ton cranes from the Middle Quay to this berth, each quay will ultimately be equipped with five electric 10-ton grabbing cranes. The work at the second berth has involved strengthening of the crane track and installation of electric cables and other ancillary works, and it is expected that it will be in commission early next year. The estimated cost of this scheme is approximately £150,000, and although it has been primarily designed to cater for the increasing imports of iron ore resulting from additional blast furnace capacity provided by Messrs. Richard Thomas and Baldwins, Ltd., at their Ebbw Vale Works, the cranes will be of a type which will permit of the berth being used for other types of cargo.

A £1¼ million scheme has recently been authorised to provide improved facilities for general cargo working at the South and North Docks. The main features are the replacement of one transit shed at the South Dock by a much larger shed measuring 600-ft. by 100-ft. designed on modern lines and equipped with up-to-date mechanical handling appliances, and the erection of a new transit shed at the North Dock. Additionally, twenty new 3/6-ton electric cranes are to be provided for the South Quay and twenty of the existing 3-ton and 6-ton electric cranes will be

## *Post-war Port Developments in the U.K.—continued*

transferred to the North Dock; the existing old hydraulic cranes at this dock will be scrapped. The main dock roadway is to be widened, thus giving improved access for road transport to and from the South Quay.

A few years ago the electricity supply at the port was improved by the provision of a new 11 KV Ring Main, at a cost of over £43,000. The Impounding and Hydraulic Power Stations have also been replaced by electrically-operated impounding and multi-stage high pressure hydraulic pumps, at a cost of approximately £130,000.

Further improvements in recent years have been the provision of cargo handling appliances, e.g. fork lift trucks and mobile cranes.

The towage facilities of the port have been improved by the purchase of two modern tugs—the s.t. " Gwent " (I.H.P. 800), and the m.t. " Newport " (S.H.P. 700)

Development by private traders is also contributing to the improvement of the facilities at Newport Docks. The Atlantic Shipbuilding Co. Ltd., which was only formed about four years ago, has established a shipbuilding yard on the Dock Estate from which already four vessels of about 3,000 tons deadweight class have been constructed. This is an entirely new industry for South Wales and the design of the ships built at this yard is based on the novel method of prefabrication. The firm are also providing a new dock to build vessels up to 60,000 tons, as well as an extension of their shipbuilding yard.

Messrs. C. H. Bailey Ltd.—a ship repairing firm in South Wales—have converted a length of quay previously used as a coal shipping berth, into a ship repair berth, and adjacent thereto have provided facilities for oil separation.

Shell-Mex and B.P. Ltd., have constructed an Oil Storage Depot with accommodation for loading and discharging coastal tankers in the South Dock, the depot and jetties being linked by a series of pipelines.

**Port Talbot Docks.**

In 1952, a new 11 KV Ring Main was installed in connection with additional and improved electricity supply at the docks, at a total cost of £36,000. In that year also, the erection of a new impounding and hydraulic pumping station was completed at an expenditure of £100,000. This station comprises three electrically-driven impounding pumps of 22,000 gallons-per-minute capacity, and five electrically-driven hydraulic pumps with capacities of 350 gallons per minute.

New lock gates of welded steel construction have been ordered, together with new lock gate machinery. The new gates will replace the existing ones which will be taken out, overhauled and held as spares for use in case of emergency. A slipway is to be constructed adjacent to the lock in the channel entrance to accommodate the spares gates, so that these can be readily accessible in case of need. A new dolphin is also to be provided in the entrance channel to take the place of the two existing dolphins, which have reached the end of their effective working life. The estimated cost of all these improvements at Port Talbot is over £150,000.

To meet the needs of the bulk import trade, an expenditure of £175,000 has been authorised on modernising the cranage facilities at the Talbot wharf extension this includes the provision of four 10-ton electric portal grabbing cranes, a new crane track, additional electricity supply and improved road access.

To improve the dredging operations in the entrance channel, a new grab dredger was purchased in 1954 at a cost of £135,000. This vessel, which was designed by the Commission's engineers, is a single-screw diesel-propelled twin grab hopper dredger. It has a unit operating cost of about half that obtained with existing dredging craft employed at South Wales, and has been designed specially to deal with the particular needs of the port.

The Abbey Works of the Steel Company of Wales are situated at Port Talbot adjacent to the docks. Margam Wharf, Port Talbot Docks, where the imported iron ore is discharged, has been extended and equipped with four modern transporter cranes and a conveyor system for the conveyance of the iron ore from ship or stock pile to the works.

Discharging iron ore at Margam Wharf, Port Talbot.

**Swansea Docks.**

The British Transport Commission have approved an expenditure of approximately £700,000 at Swansea for the purpose of increasing locking capacity and ensuring as far as possible, that the dock system is capable not only of dealing with the existing heavy trade of the port with expedition, but also to cater for the forseeable needs of the future.

The work covered by this expenditure includes: (1) the building of a new approach jetty outside the lock entrance at which vessels may lie waiting turn to dock; (2) an extension of the existing riverside roundhead and related dredging in order to enable large ships to swing in the entrance and return to sea when circumstances necessitate such a manœuvre; and (3) the installation of a new pumping system comprising two large pumps, each of 100,000 gallons-per-minute capacity, with ancillary works such as suction and discharge culverts, and a new pumphouse, etc., with the express object of making it possible to maintain a depth of water in dock of not less than 33 feet.

Approximately £300.000 has been spent on a new Ring Main and re-organisation of the L.T. services at the King's and Prince of Wales Docks, the replacement of the steam plant for hydraulic power at three power stations by electrically-driven turbo pumps, and the re-organisation of the electrical services at the South Dock.

To meet the needs of the increase in the general cargo trade at Swansea, the Commission has given consideration to the modernisation of the existing equipment. £80,000 has been incurred in re-organising the cranage facilities by augmenting the 3-ton electric cranes at present in service and scrapping a number of hydraulic cranes. A further £24,000 has been spent on the provision of five Taylor Jumbo cranes and one 6-ton mobile crane, four Calfdozers, eight Westwood self-dumping grabs, and four scrap grabs, and to expedite the discharge of scrap iron cargoes the Commission are equipping four cranes at the King's Dock with electric magnets.

So far as coal shipping appliances are concerned the Commission are spending £80,000 to replace two of the coal hoists in the King's Dock.

Messrs. B.P. (Llandarcy) Ltd., have leased from the Commission the greater part of the Queen's Dock in connection with their oil trade. They have replaced the old timber jetties by the construction of five concrete jetties, and they have also constructed a coastal tanker jetty, a number of lay-by berths and a network of oil installations on the dockside.

Another important development by a private firm is the proposed construction of a new dry dock by the Prince of Wales Dry Dock Co. Ltd. This firm has already effected certain improvements to their ship-repairing facilities by reconstructing a repair jetty in the Queen's Dock, and they are now providing for another repair berth in this dock. Tank cleaning and gas-freeing plant has also been installed by the firm.

*Post-war Port Developments in the U.K.—continued*

# The Port of Belfast

Since the end of the 1939-45 War, the Belfast Harbour Commissioners have undertaken improvement schemes which, on completion, will give 3,500 lineal feet of new quayage (mostly deep-water berths) and about 5,000 lineal feet of re-built or re-constructed quays. The progress of the work is indicated as follows:—

When the work is completed, the new and re-constructed quayage will represent about 22 per cent. of the total quayage in the Port.

Work completed includes the re-construction of Queen's Quay (1,800-ft.) and the quays at Abercorn Basin (1,050-ft.), together with the deepening of the berths alongside; the re-building of the Musgrave Shipyard Delivery Wharf (250-ft.), at which iron and steel are discharged for Messrs. Harland & Wolff's Musgrave Shipyard; the widening of the navigable entrance to the Spencer Dock; a new coal discharging wharf (407-ft.) on East side of Herdman Channel to serve Belfast Corporation's recently erected Power Station West; and the newly constructed deep-water Sinclair Wharf (1,240-ft. long) on the East side of Herdman Channel, dredging the berth of which is being carried out.

Work jn progress includes a new deep-water wharf (650-ft. long) on the West side of Victoria Channel in connection with the installation of a new 200-ton crane; new berthage accommodation (1,215-ft. of quayage) for British Railways' freight services on the West side of Herdman Channel, and the re-construction of Albert Quay (1.480-ft.) in conjunction with the deepening of the berth alongside. The first two schemes are well advanced and will be completed during 1958.

**Sheds.**

New transit shed accommodation covering 226,000 square feet of ground is being provided. The previous shedded area of 961,000 square feet is thus being increased by 24 per cent.

**Cranage.**

Apart from the 200-ton crane, which is on order, ten new 5-ton level luffing travelling electric grabbing cranes have been installed and three more are in course of erection.

**Sinclair Wharf.**

Some technical details concerning Sinclair Wharf and the 200 ton Crane Wharf will indicate the type and scope of the work being undertaken. The former is 1,240-ft. long, providing a depth of 30-ft. at O.L.W. with provision for eventual deepening to 35-ft. The wharf is constructed with a flat reinforced concrete slab supported on a piled foundation, the site being on land reclaimed about 75 years ago.

At this site the berth was formed by dredging away the bank after the wharf was built, and the design adopted was one in which the retaining wall is at the front of the wharf, thereby largely

Dredging bank in front of new Sinclair Wharf.

New deep water wharf, Headman Channel East. General view of southern end of wharf.

eliminating the effect of the surcharge behind the wharf, the standard for this being 5 cwt./sq. ft. in Belfast. The width of the deck slab also allows the ground level to be sloped underneath, thus reducing the height of the retaining wall and allowing the ground immediately behind to be self draining.

The wall was formed of composite panels of Larssen No. 4 Section box piles and No. 5 Section sheet piles, the box piles also acting as columns to support the deck slab. This was tied back by means of $2\frac{3}{4}$-in. diameter mild steel tie rods to mass concrete anchor blocks placed 95-ft. behind the coping. 14-in. x 14-in. reinforced concrete raker piles were also driven at about 14-ft. centres, their chief function being to take the loads from the coping mooring bollards.

The deck slab, 28-ft. wide. is a reinforced concrete flat slab, 2-ft. deep, on top of which is a wearing course of average depth of 7-in. which houses the crane and tram rails. The wharf is equipped with two lines of sidings and 16-ft. gauge crane rails and is capable of carrying 15 ton travelling and 6 ton mobile cranes. At the south end of the wharf, a connection has been made to the existing wharf at Pollock Basin by means of a knuckle of similar construction to the wharf. This gives the necessary access for the vehicular ship to shore connection in the adjacent berth.

About 270,000 cub. yards of material is in process of being dredged from the front of the wharf and approaches. This material is used in the Commissioners' land reclamation scheme.

The accommodation is to be provided with a transit shed of structural steel 1,100-ft. long with a clear span of 120-ft. The height of the shed is 36-ft. at eaves level and 47-ft. at ridge level. The clearance between the bottom boom and shed floor is 30-ft., enabling mobile cranes to operate in any position at maximum load. The roof will be clad with aluminium "Rigidal" corrugated sheeting. A concrete dado wall 5-ft. high will be constructed at all fixed blinds and the sheeting used above will be "Galbestos" 22 gauge.

The standard shed doorways are 18-ft. 9-in. wide and 20-ft. high. In addition, one door in five is being made 28-ft. high to allow the easy working of mobile cranes. The doors are of timber construction as it has been found that this material has a greater resistance to damage from traffic. On the water side, doors and fixed blinds alternate and on the road side the doors are at 60-ft. intervals.

**200 Ton Crane Wharf.**

This wharf is situated on the West Twin, on the West side of the Victoria Channel. It is being provided chiefly to handle heavy electrical equipment to be shipped through the port of the British Thomson-Houston Company from their new factory at Larne, Co. Antrim. The wharf is 650-ft. long, the 200 ton crane being centrally sited. A berth 750-ft. long with 30-ft. at O.L.W. will be dredged and provision is being made in the construction for the berth to be deepened to give 35-ft. at O.L.W. A transit shed 170-ft. long x 60-ft. span is also being provided.

The ground conditions are similar to those at the Sinclair Wharf.

## *Post-war Port Developments in the U.K.—continued*

**Particulars of Crane when Completed.**

The crane is a monotower cantilever crane designed to lift 200 tons at 95-ft. radius. The cantilever arms are of unequal length, the longer arm is 140-ft and the shorter arm 83-ft., measured from the centre of rotation to the extreme ends. and the overall height of the crane is about 166-ft. The unladen weight is about 1,250 tons.

A travelling trolley is mounted on the top of the long arm to transport the loads on the main hoist and the short arm is counterweighted with ballast blocks and the hoisting machinery, placed at the extreme end for the purpose of stability. On the underside of the longer cantilever arm at one side, a special track is fitted to carry a travelling trolley or whip hoist for dealing with loads up to 5 tons at high speed.

The crane is capable of hoisting, racking and slewing through 360° in either direction. The three independent hoisting hooks operate at the radii shown below and each can be raised to 125-ft. above and 35-ft. below quay level.

**Main Hoist**
200 tons at 95-ft. radius.
100 tons at 125-ft. radius.

**Auxiliary Hoist**
25 tons at 130-ft. radius.

**Whip Hoist**
5 tons at 130-ft. radius.

The crane is electrically operated with current at 400 volts, 3 phase, 50 cycles. Telephones are installed to permit conversation between the crane-driver's cabin, machinery house and ground level. The crane is fitted with aircraft obstruction lights.

**Foundation for Crane.**

The crane foundation consists of 84 box piles Larssen No. 3 Section in lengths up to 82-ft., surmounted by a reinforced concrete cap 12-ft. deep. The whole is surrounded by a cofferdam, the space under the cap, which is largely below the waterline, being filled with "Colcrete." Part of the mass of "Colcrete" is supported independently of the cap by means of twelve 12-in. square timber piles 35-ft. long.

The remainder of the wharf, which extends for 300-ft. on both sides of the crane foundation, is 37-ft. 3-in. wide. It is of piled construction and can carry a ten ton travelling crane and 7½ ton mobile cranes.

The 200 ton crane is being designed and built by Sir William Arrol and Co. Ltd. of Glasgow. and the two wharves and crane foundation are being constructed by Messrs. Charles Brand & Son, Ltd., London. The transit shed at the Sinclair Wharf will be erected by Messrs. Harland & Wolff, Ltd., Belfast.

The dredging is being carried out by the Commissioners' plant.

**Expenditure.**

Improvements carried out since 1945 have cost £1 million, and the current programme of work is costing a further £3½ millions.

Tenders will shortly be invited for the construction of the wharf for British Railways on the West side of Herdman Channel. The existing Herdman Channel Wharf is to be extended Northwards over a length of about 1,215-ft. This will give three additional berths with a large transit shed, 690-ft. long, for the reception and sorting of cargo. There will be a loading bay for road traffic in the shed. The quays will be equipped with the latest types of cranes, viz., one 12-ton and two 7½-ton portal cranes, and two transporter cranes each capable of lifting 15 tons. There will be ample open space for the handling of containers and provision will also be made for the shipment of livestock.

Apart from freight carried in their passenger vessels, which will continue to berth at Donegall Quay, all the cargo services of British Railways at Belfast will be concentrated at these new berths.

When this work is completed. there will be a continuous length of quayage (including Herdman Channel Wharf) on the West side of Herdman Channel totalling 1,900-ft.

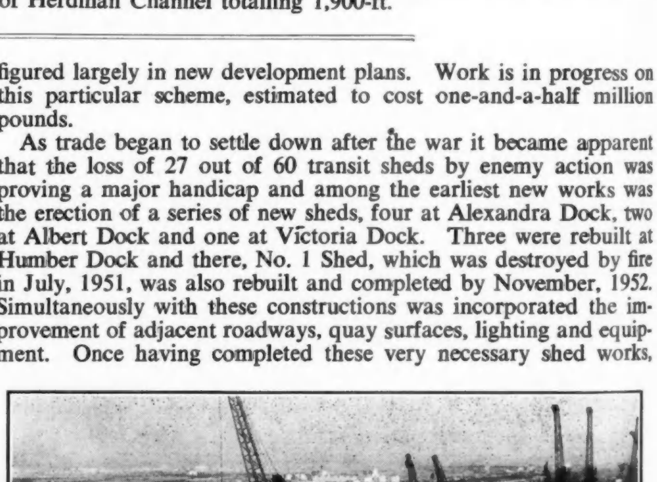
# The Port of Hull

In the decade prior to the outbreak of war in September, 1939, reasons of economy had restricted expenditure on the Hull Docks by the owners at that time, the London and North Eastern Railway Company. During the war years and in those immediately afterwards shortages of labour and materials added to the arrears of engineering maintenance and construction. It must also be remembered that the port facilities suffered heavily from enemy air-attacks in the war and the Authorities were faced, in addition to arrears, with a heavy burden of war damage repairs and reconstruction.

By the time the British Transport Commission took over the docks an overall plan of action had been formulated by the London and North Eastern Railway Company but, owing to the difficulties of labour and materials, it had not then been practicable to do much in the way of implementation. It was with this background that the British Transport Commission faced the post-war development programme, which aimed at a high degree of modernisation of the port and its equipment.

A far-reaching scheme was produced incorporating, as far as possible, the essential first-aid repairs and maintenance along with the capital projects envisaged. Thus throughout the post-war years the necessity for aligning engineering activity with the major developments has had to be borne in mind, and the views of the various trades have at all times been considered, both as regards details of individual works and relative priorities. The range of these plans may be understood when one considers that from the Salt End Jetties in the east to the St. Andrew's Dock in the west there is more than seven miles of river frontage, behind which lie eleven docks with a total water area of 200 acres and land areas of the dock estate amounting to 1,690 acres. Serving these areas is an intricate system of dock railways involving 190 miles of track and providing direct rail access to berths throughout the twelve miles of dock quays. The larger of the two riverside quays was completely destroyed by enemy action and its replacement has figured largely in new development plans. Work is in progress on this particular scheme, estimated to cost one-and-a-half million pounds.

As trade began to settle down after the war it became apparent that the loss of 27 out of 60 transit sheds by enemy action was proving a major handicap and among the earliest new works was the erection of a series of new sheds, four at Alexandra Dock, two at Albert Dock and one at Victoria Dock. Three were rebuilt at Humber Dock and there, No. 1 Shed, which was destroyed by fire in July, 1951, was also rebuilt and completed by November, 1952. Simultaneously with these constructions was incorporated the improvement of adjacent roadways, quay surfaces, lighting and equipment. Once having completed these very necessary shed works,



Two shore-based and one floating pneumatic grain elevator discharging grain at No. 1 Quay, King George Dock, Hull.

## *Post-war Port Developments in the U.K.—continued*

attention turned to the modernising of other structures. Concrete floors were laid, roofs and walls repaired as necessary, improved lighting provided and the quays, railway lines and roads brought up to modern requirements.

Reference to warehouses and transit sheds must include the rehabilitation of the large wool shed at King George Dock which is now being undertaken at an estimated cost of £43,300. This extensive building was another war casualty and when available again will prove a most helpful asset in dealing with the import of Australian and New Zealand wool, which normally approaches 100,000 tons a year.

By late 1950 the more pressing of the capital projects were being given the necessary authority and among the first of these was the re-equipment of the Wades Cranes Berth at William Wright Dock. New electric travelling cranes of 3-ton capacity at 65 feet radius were installed to replace 3-ton and 1½-ton hydraulic cranes of 30 feet radius. The berth was re-paved and provided with flush rail tracks and electric capstans for the movement of wagons. New crane tracks were laid, capable of carrying 10-ton capacity cranes in anticipation of future developments.

At King George Dock the timber decking of No. 12 Quay had gradually deteriorated over 35 years of good service and a plan to replace the whole quay structure, 1,320 feet in length, with reinforced concrete and concrete slab decking was carried out in 21 months at a cost of £210,000.

Nos. 1, 3 and 8 quays were also listed for resurfacing in concrete and already the work on Nos. 1 and 8 quays has been completed and is currently proceeding on No. 3 quay. Here the outlay is in the order of £110,000.

At Alexandra Dock the rehabilitation of No. 21 quay at a cost of over £40,000 is well on the way to completion and this will be followed by the repaving, strengthening of foundations and renewal of crane and wagon tracks at No. 28 quay at a cost of approximately £20,000. Work has started on the renewal of crane beams and timber decking at the River Pier involving the removal of the waterside rail lines and the widening of the crane track to 13-ft. 6-in. This calls for another £20,000 New lock gates for the middle lock are in process of being provided at a cost of £71,500.

Among road improvements now progressing at Alexandra Dock is the reconstruction and widening to 30 feet of the ring road between the Lock Entrance and the Extension Dock. This work, together with the reconstruction of the road near the main entrance, will cost £60,000. These road-works follow the reconstruction to a new alignment of the North Roadway between the level crossing and the United Molasses Co's. installation which was completed earlier at a cost exceeding £15,000.

At Victoria Dock, roadways have also been improved and attention is being paid to re-surfacing the timber storage areas and improving drainage. A new set of rail reception sidings has been laid on the site of a former timber pond which was filled in. Levelling work is in progress on the development of the Eastern and Western portions of the former No. 2 Timber Pond. Schemes are in hand for the improvement of working surfaces at five of the ship berths in Victoria Dock.

The replacement of steam-driven pumps at the William Wright Graving Dock by pumps using electric power is now being carried out and will cost £32,000.

St. Andrews Dock suffered by enemy air attack and severe damage was done to No. 1 Quay. Repairs are now in hand on No. 1 Quay and Fish Market and the work is expected to be completed this year at a total outlay of £420,000.

The need for quicker turn-round of shipping has called for improved mechanical handling equipment and a major contributing factor to this end is the complete re-craning of King George Dock where 45 modern electric cranes are being installed to replace the older cranes which have rendered long and useful service. Concomitant with this scheme is the conversion of the electricity supply from D.C. to A.C. and the replacement of electric cables and motors. The cranes and the conversion of power involved a total financial outlay of £950,000. The operation of these new appliances will expedite discharge or loading, whilst the provisions of a range of new type grabs for use with the cranes in dealing with various types of bulk cargoes will be a further asset.

Grain is imported in large quantities through King George Dock and, following the provision of two floating pneumatic suction elevators in 1955, a project to erect four land-based suction elevators on No. 1 quay has just been completed, costing £242,000. These elevators take the place of the bucket-type elevators which had hitherto operated there.

To assist with heavy lifts a floating crane of 60-ton capacity was obtained as an addition to the existing 80-ton floating appliance. The 100-ton fixed crane at Alexandra Dock has meantime been given a complete and thorough overhaul.

The Salt End Jetties have also figured in the port development plans. Authority has been given for the replacement of No. 1 Jetty and the provision of a third jetty with barge berths calling for a capital investment of £850,000, and certain preliminary work is at present being undertaken.

The task of reconstructing the 1,000 feet long Riverside Quay

New cranes at No. 12 Quay, King George Dock, Hull, seen from the East End.

and the re-development of the South Side of Albert Dock is now proceeding. As previously mentioned, this project will cost £1,500,000 and may be completed next year. The new quay will carry three sheds each 300 x 85 feet equipped with three 7½-ton and six 3-ton electric cranes. On the Albert Dock south quay four sheds will be built each 290 x 85 feet, and their mechanical equipment will comprise one 10-ton crane and eight 3/6-ton electric cranes. Passenger and customs accommodation is included in the Riverside Quay plans, which also provide for road works, wagon and crane tracks, electric power, water and hydraulic mains and a number of ancillary buildings.

Apart from these major schemes of development, much has been done to provide facilities in the way of new diesel tractors, mobile cranes and mechanical aids of various types. Hull ranks high among United Kingdom ports as regards the importation of timber and a drive to strengthen the port's ability to handle more efficiently

*Post-war Port Developments in the U.K.—continued*

the large volume of this traffic has included the adaptation of 1,500 ex-main line railway goods wagons to dock use, bringing the total stock to over 4,200. These wagons, used in conjunction with a stock of over 2,000 timber bogies will ease the handling of timber even at peak periods.

Reference has been made to rail tracks in connection with many of the new schemes completed or in progress but there have been many other minor improvements by the provision of new sidings to meet requirements on the various dock estates. Also worthy of mention is the post-war provision of additional sidings in the Salt End area and improved connections from the oil installations to the main running lines. A comprehensive scheme of maintenance and renewal of rail tracks is systematically progressing at an annual outlay of more than £50,000.

In common with other ports, the problem of keeping clear the entrances to the docks and the docks themselves demands a continuous programme of dredging operations. The nature of the work calls for the use of various types of craft. Bucket dredgers have a complement of attendant craft, self-propelled hopper barges, tugs and dumb hoppers. In addition suction dredgers and grab hopper dredgers are also employed.

When the British Transport Commission took over the docks many of these vessels had seen over 40 years intensive service and a large-scale replacement programme had to be faced. At that time the Humber Ports organisation embraced Hull, Grimsby, Immingham and Goole, and the dredging fleet was designed to meet the general requirements of the group, except for Goole which retained its own special equipment. In fact, although the administration of the Humber Ports has now been re-organised in some respects, the dredging power is still applied to the requirements of the ports as before.

A diesel-driven single-screw twin grab hopper dredger, with a capacity of 750 cubic yards, was built at Beverley and delivered in October, 1954 (£165,000). Meanwhile four dumb hopper barges (£114,506), two of 550 cubic yards and two of 750 cubic yards capacity, were put into service between December, 1953, and April, 1954. Then followed a single-screw diesel propelled hopper barge of 1,000 cubic yards capacity (£165,000) and a single-screw diesel tug of 420 B.H.P. In addition, and as a means of overcoming temporary difficulty, a second-hand tug was purchased for £5,500 and a steam hopper barge for £7,900. Running concurrently with this programme of replacements has been a heavy expenditure in repairs and maintenance of the dredging fleet.

The foregoing gives only a skeleton outline of the accomplishments and current operations undertaken by the British Transport Commission to modernise the Hull Docks and their facilities. When it is stated that £3,500,00 has already been spent and that works now in progress account for another £3,500,000 it will be realised that much more has been done in less spectacular ways to maintain the port of Hull in a position of prominence.

# Modern Dry Docks

## Design, Construction and Equipment

"The Dock and Harbour Authority" is proposing to publish a series of articles on modern dry docks, their design, construction and equipment. The articles will be authoritative and will attempt to cover the whole range of engineering problems associated with the subject; they will be contributed by the following writers, each of whom is a specialist in his particular field.

Analysis of Existing Position: L. H. Powell.
General Survey: E. L. Champness, M.B.E., M.Sc.
Siting and Construction: P. F. Stott, M.A., A.M.I.C.E.
Dock Gates: J. Y. Danks, B.Sc., M.I.C.E.
Caissons: F. J. Walker, A.M.I.C.E.
Pumps and Pumping; Valves and Penstocks: G. A. Wauchope.
Electrical Equipment: R. N. Benns.
Cranes: H. M. Broughton, M.I.C.E., M.I.Mech.E., M.I.E.E.
Legal Aspects of Dry Dock Construction: H. Eccles.

It is hoped that this attempt to deal comprehensively with a subject of outstanding importance to the shipbuilding, shipping and dock industries will prove of value to many readers in this country as well as abroad.

### Analysis of Existing Position

By L. H. POWELL

The earliest expedient for cleaning and repairing the bottom of a sailing ship was the process known as "careening," which Mr. F. W. Du-Plat-Taylor (a frequent contributor to "The Dock and Harbour Authority") describes in his book, "The design, construction and maintenance of docks, wharves and piers." The ship was taken into a shallow estuary or sheltered bay and as much of her ballast removed as could safely be done. She was then heeled over almost on her beam ends by means of ropes and tackle attached to the mast-heads, and hauled upon by means of capstans ashore.

All the parts of the bottom accessible were then dealt with on the side away from the shore. The ship was then righted, which sometimes required the process of parbuckling, and she was turned round and careened on the opposite side.

Although, as the writer points out, the date of construction of the earliest graving dock is not ascertainable, there is no doubt that such docks are of considerable antiquity, and it is known that the Greeks, as an alternative to hauling their ships up on to the beach for repairs, floated them into excavations made on the foreshore, from which the water was subsequently excluded by an earthen dam, and what remained under the ship's bottom was pumped or run out.

The ancients had an advantage. The slow increase in the size of vessels made it reasonable to build for a life of centuries and an unlimited supply of cheap manual labour made the execution of elaborate works feasible. Thus, most of the ancient harbours were built upon a scale of solidity and architectural grandeur seldom if ever attempted in modern times.

One of the phenomena of the present century has been the increase in the size of ships, particularly tankers. In an age not long past, the idea of a 100,000-ton ship would have been deemed impracticable and few people would have thought it worth while to go into the economic aspects of such a vessel. To-day that order of size is regarded almost as a commonplace, and there is at least one shipbuilding firm which does not place even 130,000 tons as its upper limit.

Ships are out-growing their birth-places. In shipyards all over the world there is a growing realisation that there are not the berths, the harbours or the graving docks in sufficient number to cater for the needs of the giants of the future. In America, Great Britain, the Far East and Europe schemes are already in hand for the construction of new docks or the enlargement of existing docks.

There are strategic as well as economic considerations involved in the building and operation of big ships. The question of their vulnerability in time of war may limit the number of very large vessels which will come off the stocks. The amount of steel which will be required both for building the ships and for the constructional dock works may call for a system of priorities, if normal shipbuilding is not to be interrupted. And it has still to be demonstrated that three tankers of say, 30,000 to 40,000 tons may not, in certain circumstances, be as economic to build and run as one 100,000-tonner.

Several authorities think that the large dry dock of the future should be capable of accommodating ships of up to at least 100-ft. beam. Not many ships of this measurement, apart from tankers, seem likely to be laid down in the near future, and the number of tankers of even 80,000 tons will be conditioned by the routes available to them and the docks capable of handling them.

## *Modern Dry Docks—continued*

In the next few years a considerable number of ships round about the 60,000—70,000 d.w.t. size may be laid down and the view is that the 45,000-tonner will become quite common. Mr. B. M. Mavroleon, of London and Overseas Freighters, in an analysis of the large-tanker question, argues that theoretically the 100,000-ton tanker may be built and operated more economically, and therefore more profitably, than four tankers each of 25,000 d.w.t., or three of 33,000 tons, but this has to be proved in practice. He regards the field of employment as limited and feels that the time is not ripe for independent owners to contemplate building tankers much over 40,000 d.w.t.

Another expert, Mr. A. S. C. Hulton, of Shell Tankers, holds that in spite of the amazing growth in the size of tankers, there are still some limits within which they must stay. There are, he says, many difficulties in using vessels of 80,000 and 100,000 tons, such as port capacity and transit of the Suez Canal. In terms of 80,000-ton ships must be contemplated very heavy expenditure in dredging and the construction of marine terminals to receive the ships. The size must, therefore, be "tailored" to the trades in which they are used and the ports to which they are sent.

Mr. Hulton points out that a 70,000—80,000 ton ship on the Cape route would be required to compete economically with a 40,000-tonner through the Suez Canal with dues at their present level. The capital cost of these ships, however, would be in the ratio of 4 to 3 against the Cape route. Very heavy capital expenditure would be required for the reception facilities at the discharging end, not to mention the necessary expansion in shipbuilding yards and dry docks.

As Mr. E. L. Champness puts it in an article which will appear in this series, the headache of the owner of large docks at the present time is to find them empty or used for moderate-sized ships, with only occasional use for very large capacity vessels. He sees this as a likely hazard solely in the interim period "until full usage comes with the increasing numbers of large vessels as the years go by."

The following figures (Table 1) are extracted from the statistical tables in the latest annual report of the Chamber of Shipping, and refer to December 31 last. It is explained that the figures are estimates based on the latest information that is available, and are not official. In particular, figures for Russian tonnage are known to be incomplete, and the United States figures are for vessels of 1,000 gross tons and over, whereas the other fleets are of 500 tons and over.

**Table 1. Tanker Tonnage by Nationality**

| | Gross tons (000) | | Gross tons (000) |
|---|---|---|---|
| United Kingdom ... | 5,329 | Holland ... ... | 1,085 |
| Canada ... ... | 138 | Honduras ... | 151 |
| Other British countries ... ... | 130 | Italy ... ... | 1,296 |
| (Total for British Commonwealth 5,597) | | Japan ... ... | 804 |
| | | Liberia ... ... | 3,562 |
| | | Norway ... ... | 4,559 |
| Argentine ... | 342 | Panama ... ... | 2,139 |
| Belgium ... ... | 120 | Portugal ... ... | 70 |
| Brazil ... ... | 166 | Russia ... ... | 434 |
| Costa Rica ... | 18 | Spain ... ... | 247 |
| Denmark ... ... | 552 | Sweden ... ... | 908 |
| Finland ... ... | 144 | United States ... | 4,022 |
| France ... ... | 1,336 | Other countries ... | 630 |
| Germany, West ... | 335 | | |
| Greece ... ... | 165 | Total ... | 28,682 |

Ships began as small boats. They have grown into monsters, but there are circumstances in which the trend might, perhaps, be reversed. These circumstances derive from the atomic age. It is admitted that it is not now a question as to whether nuclear propulsion will become suitable for merchant ships, but only a question of time—perhaps ten years.

It has been stated that the first merchant vessel to be so driven, at any rate in Great Britain, will be of the order of 80,000 tons. That means a tanker. But it will not be long before other types of reactors suitable for a wide range of different sizes of ships will become available. For many years there will be a state of "co-existence" between nuclear energy and conventional fuels, until the former proves its superiority in every respect. It will be the old story of steam versus sail, steel as against iron, oil competing with coal. The giant ship may, in the end, not be necessary or economic and the dry dock owner in that event will be left with a bigger headache than before.

### The Dry Docks of Great Britain.

No age seems to be completely successful in planning for the needs of posterity. That which seemed ample in size or design at one time proves woefully inadequate — or, conversely, grotesquely over-large—a century later. Scientific achievements alter the whole character of things, and human demands change with them.

Shipping is a case in point. Just over three-quarters of a century ago, a prominent shipowner—he was then president of the Chamber of Shipping of the United Kingdom—commented on the fact that the average size of the ships of that time was "no less than 1,600 tons." According to him, in 1881 naval architects held strong opinions as to whether or not the maximum length of vessels had not been, if not quite, at any rate almost reached.

An average of 1,600 tons means, of course, that there must have been a number of ships of much greater tonnage. But it must also be remembered that at the turn of the 19th century the oversea trade of this country was carried on by comparatively small wooden ships and there was not a single vessel propelled by steam in existence.

Indeed, in 1860, before the introduction of steel, the average size of iron steamers was 340 tons. In 1881, as already stated, it had risen to 1,600 tons; by 1899 the figure was 1,940 and by 1900 it was over 2,000. This increase in average size over 40 years was held to be "marvellous."

Our shipowner of the 80's pointed out that it was thought then that if vessels of still greater size should be constructed, the increase must be of beam, and consequently of depth. Where, he asked, were the docks to accommodate such vessels?

The question is posed in a slightly different form to-day. Early in 1957 the Civil Lord of the Admiralty admitted that the three dry docks most recently completed in the United Kingdom would not be large enough to dock the biggest oil tankers on order; that there was only one dry dock in the country that could accommodate tankers of up to 80,000 d.w.t.; and one other that could take them up to 60,000 tons. He added that the provision of further dry docks for commercial purposes is primarily a matter for the shiprepairing and port interests—and no one will quarrel with that assertion — although the Government was studying the various aspects of the problem presented by the trend towards bigger ships.

It would be as unfair, therefore, to blame the men of the early 19th century for lack of foresight as it would be to expect those of the early 20th to have had prophetic vision. For even now, who can foretell what size of dry dock will be required, say, 50 years hence?

The earlier graving docks in this country were of small dimensions and were built of solid masonry of substantial thickness. They resisted the various forces to which they were subjected by their weight and the thickness of their floors. (In modern graving docks these forces are of more importance, and the design consequently requires great skill and careful attention). Very fine examples of masonry dry docks were built in Naval dockyards in this country in the past.

Even in 1928, the question of the adequacy of the country's dry docks was under discussion. In his books "The design, construction and maintenance of docks, wharves and piers," Mr. F. M. Du-Plat-Taylor wrote that a critical stage had been reached in the history of the design of harbour and dock accommodation for ships. This stage was already approaching in 1914, but developments were arrested by the war. The building of very large vessels, however, was being resumed; the question of providing berths for them was again becoming acute and had been accentuated by the much higher cost of engineering work resulting from the First World War.

It is hoped that in this and future issues of this series, we shall be able to give brief details of the existing dry dock facilities throughout the world. Beginning with Great Britain, which holds

## *Modern Dry Docks—continued*

first place among the effective merchant fleets now operating, the lists will be divided into geographical sections.

According to the latest information available, the dry dock facilities now existing in the United Kingdom are as follows:—

| | Max. Length in ft. | Width of Entrance |
|---|---|---|
| Avonmouth (Royal Edward) ... ... | 875 | 100 |
| Belfast (Thompson) ... ... ... | 864 | 96 |
| Birkenhead (Cammell Laird) ... ... | 862.6 | 90 |
| Falmouth, No. 3 (Silley Cox & Co., Ltd.) ... | 750 | 87 |
| Liverpool (Gladstone) ... ... ... | 1,050 | 120 |
| Liverpool (Brocklebank) ... ... ... | 799 | 93.2 |
| Liverpool (Canada) ... ... ... | 926 | 94 |
| London (Tilbury) ... ... ... ... | 752.4 | 110.4 |
| London (King George V) ... ... ... | 750 | 100 |
| Newcastle (Palmers Hebbern Co., Ltd.) ... | 711 | 90 |
| North Shields (Smith's Dock Co., Ltd.) ... | 709 | 95 |
| South Shields (Brigham & Cowan, Ltd.) ... | 715 | 95 |
| Southampton (King George V) ... ... | 1,200 | 135 |
| Southampton (Trafalgar) ... ... ... | 912.3 | 100 |
| Southampton (Prince of Wales) ... ... | 745 | 91 |
| Sunderland (T. W. Greenwell & Co. Ltd.) | 675 | 87.2 |
| Wallsend (Swan, Hunter & Wigham Richardson) ... ... ... | 715 | 105 |

These are the only docks of the 200 or so in Great Britain exceeding 200-ft. in length which are of dimensions suitable for the handling of modern 32,000 d.w.t. oil tankers. And in the case of London, Liverpool and Southampton the dry docks are in passenger liner terminal ports and are not generally available for long-term tanker repairs.

**Under Construction or Projected**

| | | |
|---|---|---|
| Birkenhead (Cammell Laird & Co.) ... | 750 | 105 |
| " " " ... ... | 1,000 | 140 |
| Falmouth (Silley Cox & Co., Ltd.) ... | 820 | 120 |
| Greenock ... ... ... ... ... | 1,200 | 120 |
| Milford Haven ... ... ... ... ... | 1,000 | 150 |
| Newport, Mon. (Atlantic Shipbuilding Co. Ltd.) ... ... ... ... ... ... | 780 | 104 |
| Swansea ... ... ... ... ... ... | 670 | 92 |

The preparatory work in connection with the building of the two new graving docks for Cammell Laird was begun in June. The docks are part of the company's £17m. reconstruction and modernisation programme. Existing facilities permit the building of vessels up to 70,000 tons deadweight.

The final plans for the two dry docks are not yet complete, but it is understood that the dry dock in the north yard will be used mainly for repair work. It will have a length of approximately 1,000-ft. and a breadth of 140-ft., dimensions which will make it the largest dry dock on the West Coast. It will take tankers of 100,000 tons.

A scheme for harbour developments in Milford Haven include the construction of two new dry docks capable of taking the largest oil tankers. Discussions have been taking place in Glasgow on the proposed construction of a large graving dock. A spokesman of Smith' Dock Company has stated that if the world demands dry docks for 100,000-ton tankers his company will provide such accommodation. The Atlantic Shipbuilding Company has stated that discussions have been taking place with several owners about building tankers of over 100,000 tons deadweight, and indeed up to 130,000 tons.

These facts show that British companies are quite alive to the needs of the future. The inadequacy of dry dock facilities in this country has, indeed, been causing concern to the ship-repairing industry. In 1955 the chairman of the Dry Dock Owners' and Repairers' Central Council said that the need for more large dry docks was not only pressing to accommodate the greatly increased number of larger ships, particularly tankers, built, building and likely to be built, but was a vital necessity in the event of a national emergency.

The following year his successor said that shiprepairers contended that a comparison of the sizes of vessels to-day, compared with, say, 20 or 25 years ago, was conclusive proof that the dry docks built at that time were quite out of date and obsolete to-day for the purpose for which they were originally constructed.

In 1952 the Institution of Civil Engineers issued a memorandum on the construction and equipment of dry docks. This was prepared by a special committee on which served members of the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Admiralty and the Chamber of Shipping of the United Kingdom.

The memorandum pointed out that the design and construction of dry docks were subjects which, by their nature, preclude the possibility of compiling any useful code of practice. Classifications were detailed as follows:—

LARGE—Docks capable of docking the largest liners and warships afloat.

MEDIUM—Docks catering for liners and ocean-going merchantmen up to about 35,000 tons load displacement, and warships up to and including cruisers and light fleet carriers, i.e. a dock from 650-ft. to 800-ft. long, 70-ft. to 110-ft. wide at the entrance and with about 30-ft. of water over the sill at lowest predicted high-water neap tide.

SMALL—Docks for coasting vessels, harbour craft and the smaller cross-channel steamers, and for warships up to and including destroyers.

It is the large dock with which we are primarily concerned. So far as Great Britain is concerned, the big battleship is on its way out; the largest liner may well be in the neighbourhood of 40,000 gross tons, unless in time the two "Queens" are replaced by ships of similar size, namely 80,000—84,000 gross tons. We are left with the big and the "super" tanker.

The figures given above, therefore, must be read in the light of the knowledge that a 32,000-ton tanker has an average length of about 660-ft., and a beam of around 85-ft., while a tanker of over 40,000 tons would be around 730-ft. long and nearly 100-ft. wide. The width of a dry dock must be 15-ft. to 20-ft. more than the beam of the ship, for working space.

So far the very large tanker, up to 100,000 tons and over, has not been ordered by British owners, and it is unlikely, perhaps, that vessels of this size will trade to the United Kingdom for some years to come, because ports and harbours are unable to accommodate them. Lieut.-Colonel T. Eustace Smith, the chairman of Smith's Dock Company, believes that the 65,000-tonner will be the largest ships likely to be built in Great Britain for the time being.

But he insists, too, that if the larger tankers should prove to be the economic form of oil transport for the future, ports and harbours will require to be developed, as will also the building berths and dry docks. He advances the interesting theory that this will mean the building of new docks for each group of tankers—the 60,000-tonners, the 80,000-tonners and, as required, the 100,000-tonners—because it would be hopelessly uneconomic, in view of the present day cost of a large new dock, to use it for any ships other than those for which it has been constructed, and in any case it would require to be occupied more or less to capacity.

This is a point of view which has been considered by other dry dock owners. For example, Mr. J. W. Elliott, chairman of Swan, Hunter & Wigham Richardson, refers to the extraordinary situation that will be created if, by the time the major reconstruction schemes on which shipbuilders are engaged have been carried out, the arrangements on completion are found to be out of date. He, too, believes that very large ships will probably have a limited scope for some years to come, as the problems involved in operation, terminal port facilities, dry dock facilities and so on cannot be overcome quickly.

The revolutionary increase in the size of tankers has come suddenly. At the opening of the new dry dock of Swan Hunter at Wallsend in June it was stated that when the project was conceived four years earlier the dock as planned would have been capable of holding any ship in the British mercantile marine (with the exception of six) in commission at that time. That situation no longer applies and many ships have been ordered and scheduled for delivery in the next five years that will be far too big to go into the dock.

That is the measure of the dock problem in Great Britain to-day.

# Resistance of Timbers to Marine Borers

## A Survey of Some Recent Experimental Work

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THE RESISTANCE of timbers to marine borers has been the subject of innumerable articles, pamphlets and other publications and is still the subject of research all over the world. Much of the work is pure research, some of it is Applied, since it is felt that even if a timber is found to be highly resistant, if it is not commercially available, then the information is of little value to the consumer. However, the above statement can possibly be modified since, with the advent of waterproof glues and the techniques of laminating, it may be possible to face a non-resistant timber with small sections of a highly resistant wood thus overcoming the non-availability of structural sizes in this particular wood. Whilst on the subject of laminating, the full possibilities of this method have yet to be investigated since by using such methods the shortage of large piling timbers, such as 24-in. x 24-in. x 50-ft. and more could be overcome.

Articles dealing with the question of the squared pile versus the round pile ([1]) and with timbers for use in maritime works ([2]), and with marine borers ([3]) have already appeared in past issues of the "Dock and Harbour Authority," and it is not the intention of the writer to repeat this data. It is felt what is now required is a survey of the work being carried out in different parts of the world, mentioning the appropriate authorities and the results so far achieved. In this respect certain factors have to be borne in mind when selecting timbers for marine use. From careful examination of these tentative results it has been found that curious anomalies exist, in that timber with high resistance to marine borers in one part of the world can show the reverse at other research stations, and it is felt that temperatures, salinity, current velocity, and light intensity all have a direct bearing upon the intensity of attack and must be taken into consideration.

**Brief Historical Survey.**

It is appropritate here to mention briefly some of the work which has been done in the past before bringing the picture up to date as far as possible, and it must be noted that the picture is by no means complete. The presence of *Teredo* and its depredations in timber has been known for a long time, but serious scientific study was not begun until the 18th Century. A Dutch naturalist Godfrey Sellins can be said to have written the earliest treatise on this pest. His "Historia Naturalis Teredinis, sen Xylophagi Marine" was published in 1733 and dealt with the damage to the dykes in Holland. Others took up the task and in the 19th Century many important papers and treatises were published. The writers tended to concentrate on the biology of the pests and it is interesting to note that it was not until 1923 that Dore & Miller, investigating the nutriment of the *Teredo*, discovered that the pest was able to digest the cellulose and hemicellulose of wood. Until then it was believed that the "worm" entered timber only for the purpose of sheltering from its enemies and that its food consisted of plankton and other micro-organisms brought into the digestive system by means of its siphons. There is still much being learned concerning the feeding habits and life cycles of *Teredo*.

Another important wood destroyer is the *Limnoria* or *Gribble*. The damage caused by this pest is far more insidious and prevalent, at least in English waters, than *Teredo* and only recently has attention been paid to its life cycle. W. T. Calman in his booklet "Marine Boring Animals," Natural History Museum, mentions the fact that Robert Stevenson first drew attention to this pest when the timbers of the Bell Rock Lighthouse were being destroyed, and that specimens were sent to the Museum in 1814, but that H. Rathke had already named it prior to this date. In 1834 John Coldstream wrote a paper on this crustacean which was published in "Edinburgh New Philosophical Journal," and this has been followed by several others.

The Department of Zoology, Southampton University are at present carrying out a detailed study of the life habits of this particular pest in view of its prevalence in the waters around that area. A paper on this work and the results so far achieved was presented at this year's Convention of the British Wood Preserving Association at Cambridge. Further details of papers and books published on these two pests can be found in the bibliography published in W. T. Calman's booklet.

It is difficult to separate the pure biological from the applied research work since it is obvious that both must work side by side, but in view of the fact that wood was the first boat-building and probably dock constructional material, attention must have been drawn to the damage caused by these pests, and the resistance of certain timber to them.

The importance of these pests was realised by the Institute of Civil Engineers who formed a Committee to investigate the deterioration of structures in sea-water in 1916. Their first report was published in 1920 and a second edition of the 19th report in 1947 was published in 1951 incorporating the results of tests at Singapore, but in the intervening years eighteen reports were published covering results so far achieved. They instituted tests exposing timbers, both treated and untreated in the harbours of the following countries—Africa, Australia, New Zealand, India and the Middle East, China and the Far East and America.

Other countries took up the same type of work and it appears that Holland in particular showed great concern about the problem, although observations as to the behaviour of Greenheart were reported as far back as 1897, and a general survey was issued in 1915 as to the life of this wood. The Americans, alarmed at the depredations of these pests in San Francisco Bay in 1914, 1917 and particularly in 1919 founded a Joint Committee under the Auspices of the National Research Council of the U.S.A. to undertake a national survey. The corresponding Council in Canada took up the same work and issued a Report, made by the Atlantic Biological Station of the Biological Board of Canada under Dr. A. J. Huntsman, in 1925 on the Borers prevalent on the Canadian Atlantic Coast.

The importance of all this work was realised by many Harbour Authorities who instigated their own experimental work collaborating with the necessary biological experts, and chief of these is the work carried out by the Sydney Harbour Trust commencing in 1927.* A report was issued in 1932 by T. Iredale, R. A. Johnson and F. A. McNeill and supplementary reports have been issued in 1932 and 1941. The San Francisco Bay Marine Piling Survey has also carried on the work, as has the U.S. Naval Civil Engineering Research and Evaluation Laboratory. A most important document published by C. H. Edmondson, Marine Zoologist of the Bernice P. Bishop Museum, Bulletin 217, Hawaii on the "Resistance of Woods to Marine Borers" in Hawaiian Waters" together with his paper on the "Response of Marine Borers to Chemically Treated Woods and Other Products" could be described as a complete reference to this problem since practically all known timbers, barring some of the best known African woods, have been tested and their evaluations tabulated.

Another source of information is the Bulletin No. 223 which is a "Report of Marine Borer Survey in New Guinea" issued by the Council for Scientific and Industrial Research of Australia. Apparently no submersion tests were undertaken but the Report contains valuable information on the distribution of species together with evidence of how various timbers behave in those waters.

Various papers on these problems were read to the Pacific Scien-

[1] Volume XXXIV, September, 1953.
[2] Volume XXXV, March, 1955.
[3] Volume XXXIII, December, 1952.

## Resistance of Timbers to Marine Borers—*continued*

tific Congress in 1932, and a special conference entitled "Marine Borer Conference" was formed, meeting in 1952 and again in 1956.

As a result of the Hardwood Overseas Procurement Order No. III 1946, a large number of new timbers appeared on the English market and with the then shortage of Pitch Pine, Teak, etc., the suitability of these woods for various purposes, including marine work, was a subject requiring attention. Accordingly the Timber Development Association inaugurated a series of exposure tests at Shoreham Harbour (1952) to determine the resistance of these newer timbers to the *Teredo*.

Various Forest Departments in Africa are also carrying out submersion tests on their timbers as well as the Ministry of Supply, Tropical Testing Establishment at Port Harcourt, Nigeria. This list is by no means exhaustive but it does show how much importance is being attached to this problem by authorities all over the world and much valuable information is being obtained.

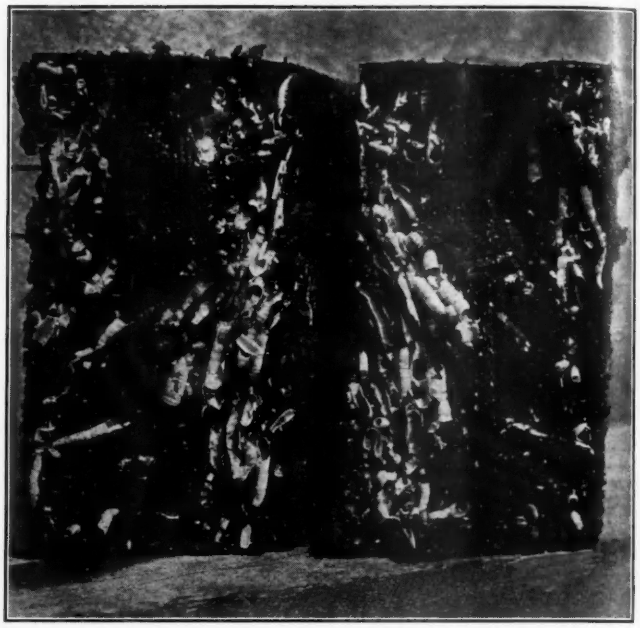
**Techniques.**

The rapidity with which these borers, *Teredo* and *Limnoria*, will strike, offers fairly quick results in eliminating, in a matter of months, the unsuitable or non-resistant timbers. On the other hand, to determine the life of a wood subjected to these enemies is a long-term process, and one which is also complicated by the presence of fungi, mainly *Chaetomium spp* (*Ascomycete*) and other micro and bacterial organisms. The softening of the surfaces of timbers in water can largely be attributed to these organisms, in addition to hydrolysis.

From a study of reports, bulletins, correspondence and conversations there appears to be a wide diversity of methods of testing timbers, and particularly in the analysis of results. In brief, one could say that the immersion of blocks is the general method, but there appears to be a divergence of opinion as to the best size to adopt. The Timber Development Association method is to use 6-in. x 6-in. x 3-in. blocks with a ⅞-in. hole drilled through the centre. These are then strung on rods on a 6-ft. x 4-ft. metal frame, the blocks being left apart by 1-in. distant pieces. Results achieved are satisfactory.

The Institute of Civil Engineers' tests appear to use a variety of dimensions, 12-in. x 6-in. and 9-in. x 6-in. x 6-ft.; 12-in. x 8-in. x 2-in., 4-in. x 4-in. x 4-in., 36-in. x 12-in. x 6-in. are some of the sizes which are set in a solid frame for submersion. The Dutch authorities in their 17th report used a smaller sized block 30 x 7 x 5 cm. which was 1/4th of the size previously used. Port Sydney

Two methods of testing specimens used by Timber Development Association. In the foreground control rods of Corsican Pine.



Beech Trial Block after two years' exposure showing severity of attack from Teredo Sp.

used blocks 3-in. x 3-in. x 5-ft. No reference can be found in the report by C. H. Edmondson on the sizes used in the Hawaiian tests but one could generalise on a minimum thickness of 2-in. and lengths would vary according to the purpose of the test. If merely to determine whether a wood is resistant or not, as in the T.D.A.'s tests, then lengths are unnecessary, but if to determine the main areas of attack, or depths at which attacks occur, then obviously longer pieces are required.

The technique of examination also seems to vary. The minute entry holes of the larvae of *Teredo* can be missed quite easily by an untrained eye, and cutting must be resorted to to determine depth of penetration. Visual evidence of *Limnoria* is, of course, quite easy and presents no difficulty. The T.D.A.'s technique is to cut off a small corner, and to make a "V" shaped cut on the edge of the block. This informs one of the presence and size of the *Teredo* tunnels, but it also destroys those present. However, this is immaterial if the purpose is merely a screening test. The greatest difficulty would appear to be when preserved specimens are being examined. Duplicate sets under identical conditions could be used, reserving one for cutting, but the possibility of using X-rays stereoscopy should not be overlooked, since this permits the examination of specimens in viva. This technique has been used successfully by D. J. Crisp of the Marine Biology Station, University College of North Wales in collaboration with the I.C.I., Marine Research Station and Messrs. Ilfords. The illustration (Fig. 1) of a sample of marine quality plywood submerged for 1 year at Shoreham, shows the extent of attack by using this method without cutting the specimen.

In the Canadian investigation an ingenious technique was used. Dr. Huntsman devised what was known as a hydroscope using the periscope principle. It was built by J. Frank Raw Co. Ltd., of Toronto, and was found most useful for examining piles and structures below low water level.

From the above it would appear that some form of standard method of examination, together with a standard size of specimen, according to its purpose could be formulated. The Forest Department at Mombasa has already drafted such a specification and the writer feels that this could well be discussed at one of the Conferences mentioned previously.

Some interesting findings were discussed at last year's Marine Borer Conference held in Wrightsville, North Carolina, and published by the British Commonwealth Scientific Office (N.A.)

## *Resistance of Timbers to Marine Borers—continued*

The top block showing the attack is Canarium and the lower block is Afrormosia. The small entry holes show clearly. This also shows method of examination of corner cutting.

Washington. Perhaps the most interesting is in respect of recent taxonomic work on *Limnoria*. Previously it was considered that *L. lignorum* was the only specie, but it has been found that a new species *L. tripunctata* occurs; Dr. R. Menzies of Columbia University first described this in 1951. The distribution of the former is confined to the Northern waters of U.S.A. and the new one occurs in the Southern waters and is probably far wider spread than was thought. In addition the Conference was informed that Marine Borers were present in the Persian Gulf, where hitherto it had been reported as being free.

The resistance of marine borers to various preservatives was also discussed, and it was shown that *Limnoria* was more tolerant to creosote. Dr. Menzies found that the specie was *L. tripunctata* and could survive or feed in creosoted timber normally free from other borers.

The emphasis at this Conference appeared to be on the *Limnoria*, confirming the writer's belief that this pest is more serious than the *Teredo* and other species. Many other topics were discussed, such as deterioration of materials, toxicity of chemicals, survey of methods of protecting timber and, in conclusion, the need for research, the lines to be tackled and future programmes.

**Resistance of Timbers.**

All the experimental work being undertaken has a two-fold object:

(1) To discover the natural resistance of timbers, and

(2) The suitable chemical treatment needed to increase resistance of timbers with low resistance.

Certain timbers are already known to have a high resistance, such as Greenheart, Pyinkado, Turpentine, Totara (a softwood—*Podocarpus totara*), Jarrah, Basra locus, Manbarklak, Belian and other species. Attention has been drawn to this well known fact and a series of investigations have been carried out to ascertain the cause for this immunity. Apart from certain toxic chemicals which tend to leach out, it has been found that Silica, $SiO_2$, is the chief substance offering resistance to *Teredo*. The Wm. F. Clapp Laboratories in the U.S.A. undertook a series of tests which showed that 0.5% of Silica appeared to be the minimum concentration necessary for comparative immunity. An examination of the tests all over the world, where analysis of the woods is undertaken, generally confirms this belief.

Another factor also apparent from a study of results achieved, is that the behaviour of a wood differs according to the geographical locality of immersion, tropical waters being far more harmful than those in temperate regions. In the former the marine population is more extensive—*Teredo, Limnoria, Martesia, Xylophaga, Sphaeroma, Chelura* are the chief genera attacking timber—and their distribution and concentration also varies. Examples of this may be quoted here. The T.D.A. experiments have shown that Okan—*Cylicodiscus gabonensis*—has shown no sign of attack after six years' immersion, when Mora has been destroyed in six months. The Tropical Testing Establishment at Port Harcourt reported that after three months' exposure Opepe showed slightly better resistance than Okan, whereas the T.D.A. tests showed Opepe as having only moderate resistance. In this respect it must be recorded that it was *Bankia sp.* which was responsible for the damage at Port Harcourt. These differences will probably be found duplicated with other timbers at the various test stations in the world.

The T.D.A. experiments, as has been stated, are a series of screening tests for the untreated timbers, and results so far show the following ratings:

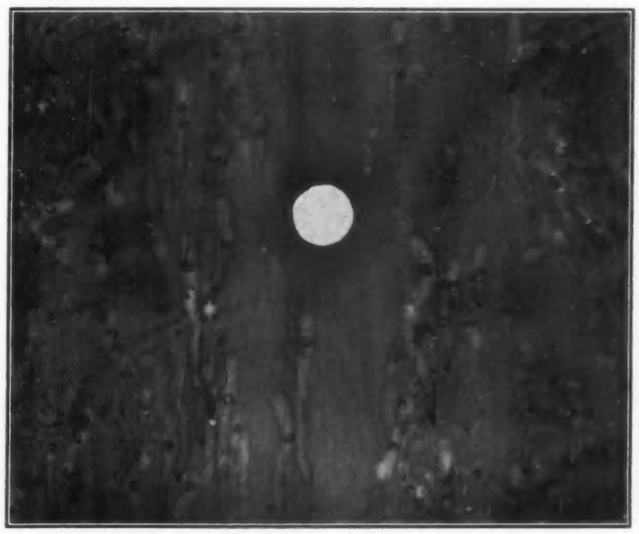
1. **Highly resistant**—Okan, Greenheart, Belian, Basra locus.
2. **Moderately resistant**—Afrormosia, Opepe, Danta, Guayacan.
3. **Low resistance**—Courbaril, Crabwood, Mugonha, Wallaba.
4. **Non resistant**—Afzelia, Canarium, Dahoma, Irul, Mora, Okwen (floater), Purpleheart.

Unclassified as yet—African Padauk, Muninga, Okwen (sinker), Keruing.

Comparing these timbers with the results obtained at Hawaii, Basra locus has been confirmed in its high resistance category. The guayacan—Tabebuia spp.—which at Shoreham, was found to have been attacked but only of a very slow order after 24 months' immersion—shows quite a different picture in Hawaii.

*T. serratifolia* was found to be riddled after tight months' immersion, an unidentified specie of Costa Rica showed a light attack after 20 months, the *T. conspicua* of Brazil a light attack after 7 months and *T. capitata* of British Guiana moderate damage after 7 months. The courbaril was riddled in 7 months in Hawaii, whereas the Shoreham tests showed slightly more resistance but could not be classed as high. Mora results were confirmed at both Stations. Unfortunately very few African species have been tested, as yet, in Hawaii, but the Forest Department tests at Kipevu, Kilindini, etc., confirm several of the Shoreham tests. Dahoma—*Piptadenia spp.*—were destroyed in under two years; in Kipevu six months only was required.

The reference to Okwen (floater) and the Okwen (sinker) is for



Weather-proof Plywood examined by X-ray stereoscopy to reveal attack by marine borers.

## *Resistance of Timbers to Marine Borers—continued*

*Brachystegia nigerica* and is due to the fact that in extractions the one floats and the other sinks. No significant difference could be found, but it is possibly one of the species grown in West Africa, since *Teredo* readily attacked the floater but so far has not touched the sinker. The Kipevu tests showed, *B. spiciformis*, as being riddled in six months, which gives support to the fact that there is a specific difference when compared with the T.D.A. tests.

The Dutch experiments confirm other findings, namely the resistance of Belian and another Far Eastern timber Lara (*Metrosideros sp.*). Greenheart and Basra locus show attempted attack which was also found with some timbers at Shoreham. In this respect the T.D.A. experiments showed that Pyinkado was attacked where sapwood was included and what has been termed the "transitional zone" between sapwood and heartwood. This feature was also noted with other timbers. A series of tests was also inaugurated in the lagoon at Venice under the care of Dr. G. F. Roch and the results there are comparable with those of the same species by C. H. Edmondson in Hawaii.

The Hawaiian report is worthy of study since it lists more than three hundred timbers, and other substances, according to their families. The final list of some twenty timbers cover those which have offered such resistance as to give a useful service period in an untreated state. These timbers were again sorted resulting in sixteen species, of which seven, marked with a star, showed pronounced resistance to *Limnoria*. These sixteen woods are as follows:

Two species of the Hawaiian genus Antidesma.*
Satine—*Brosimum paraense*, Tropical America.
Cypress Pine—*Callitris glauca*, Australia.*
Red Jequitiba—*Cariniana pyriformis*, Venez.
Basra locus—*Dicorynia paraensis*, Dutch Guiana.
Black Kakeralli—*Eschweilera sagotiana*, Br. G.
Belian—*Eusideroxylon zwageri*, Borneo.
Sapucaia—*Lecythis paraensis*, Brazil.*
Marishi-balli—*Licania densiflora*, Br. G.*
Lara—*Metrosideros petiolata*, Celebes.*
Greenheart—*Ocotea rodiaei*, Br. G.
Determa / Wane—*Ocotea rubra*, S. America.
Turpentine—*Syncarpia laurifolia*, Australia.
Milla—*Vitex pinnata*, Malaya.
—*Viticipremna novae-pommeraniae*, New Guiriea.*
which showed high resistance.

It is significant that most of these timbers showed high concentrations of Silica, the endemic genus *Antidesma* of Hawaii giving as high a concentration as 3%. It is also apparent that density of wood substance cannot be quoted as a criterion of resistance, but on the other hand concentration of certain alkaloids in some timbers will give resistant powers.

At this point some curious results may be recorded regarding the timber, Turpentine, *Syncarpia laurifolia*—grown in Hawaii as opposed to the Australian grown timber. The latter showed considerably more resistance than the former, and Amos and Dadswell in a paper in the Journal for Scientific and Industrial Research 1948, showed that the average Silica content of the Hawaiian material was .091% compared with .59% for the Australian material. This implies therefore that a tree grown in its natural environment will vary considerably in its properties, when compared with one grown in a different habitat. This holds true for all timbers whether for marine use or for other purposes.

An interesting aspect of the work carried out by the Port of Sydney Authorities deals with the effect of fresh water upon *Teredo* in timber. It has been found that immersion in fresh water for a period of ten days and over will kill the *Teredo*. This is of considerable importance to owners of wooden vessels, pontoons, etc., where fresh water facilities are available. It also confirms that the action of slipping craft is not sufficient to completely kill *Teredo*, since they can survive removal from the water for several days or even longer.

The East African timber tests carried out by the Forest Department, Mombasa, at Kilindini, naturally concentrate upon indigenous species. After eighteen months' exposure Ngambo—*Manilkara cuneifolia;* Copalwood—*Trachylobium verrucosum;* an unidentified species known as Mburu mburа are classified as resistant 1—1 the first named being the most impervious.

At Kipevu, only Cedar, *Juniperus procera*, showed any resistance after six months followed by Podo, *Podocarpus spp.*, and the remaining eight species in all, were showing heavy infestation to complete destruction in the same period. The Department has given certain categories for timbers according to their resistance, the highest being those timbers suitable for use untreated for periods not exceeding eight years. In this "A" category are the following:

*Afzelia quanzensis—Mbambakofi.*
*Chlorophora excelsa—Mvule / Iroko.*
*Terminalia prunoides—Mwangati.*
*Brachylaena hutchinsii.*
*Manilkara cuneifolia.*

All these tests and many others, are extending the range of timbers suitable for marine use in their untreated state, but it must be remembered that it is unsafe to give any sweeping statement as to the overall superiority of any one timber. If it is possible to generalise at all, it could be said that timbers showing resistance in tropical waters could be used with considerable confidence in temperate waters, taking into due consideration the distribution of the borers and the availability of the timber.

Throughout this article no reference has been made to tests using wood preservatives, for parallel with those on untreated timbers similar ones are in progress using various wood preservatives. In collaboration with the British Wood Preserving Association, the Timber Development Association has inaugurated a series of fender tests in Poole Harbour, Dorset, utilising a wide range of preservatives at different concentrations for their suitability against *Limnoria*. A new series of screening tests is also in progress at Shoreham.

It is felt that there must be many omissions from the experimental work which is going on throughout the world and that many authorities have not been consulted, but the endeavour has been made to give, where possible, some practical information. A list of papers and documents consulted is added and it is hoped that this article has shown the extent of the problem and the work which is quietly going on in an endeavour to find satisfactory answers.

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# Maritime VHF Radio Telephone Service

## New International Agreement

By I. CAMPBELL-BRUCE.

A NEW Radio Telephone Service, operating on Very High Frequencies and using Frequency Modulation, is now being added to the existing International Maritime Radio Services. This service is basically similar to the new high quality system of broadcasting now being provided by the B.B.C. and other broadcasting organisations, and marks a similar improvement in clarity and freedom from interference.

FM broadcasting operates in a frequency band of 87.5—95 Mc/s (about 3 metres wavelength), and the new Maritime FM communication service, between 156 and 162 Mc/s (a little under 2 metres). In between is the International Aeronautical VHF band which has, for many years, provided an excellent radiotelephony service for use by Captains of Aircraft. Agreement on a world wide aeronautical VHF system came swiftly as a result of Anglo-American war-time developments, but it has taken many years of peace time international discussion to reach the present stage on the maritime side.

**International Agreement.**

At the Baltic and North Sea Radio Telephone Conference at Gothenburg in September, 1955, an informal agreement was reached on the problem of maritime VHF, making certain recommendations towards international working. The International Radio Consultative Committee of the International Telegraph Union meeting in Warsaw in August and September, 1956, made recommendations on technical standards, and at an International Maritime VHF Conference at the Hague in January convened by the Netherland's P.T.T., agreement was reached on frequency channels and operating procedure by the Administrations of the Baltic and North Sea countries. Members of the International Telegraph Union, including U.S.A., Canada and Italy who were represented at the Conference and were in general accord, are being invited to join the agreement which is due for implementation, by the Hague signatories, on October 1st, 1957. Poland and the Soviet Union were among the signatories to the agreement.

One of the main points is the establishment of an International Calling and Safety channel on VHF, as well as a system of frequency allocation aimed at providing communication with coast stations, Port networks and other ships, throughout the world; another is the emergence of the VHF FM system primarily as a Bridge Telephone under the operational control of the Captain or officer on watch, even though it may be switched temporarily for convenience to another point on board, for ship's business.

By close channel spacing, necessitating radio equipment of a high standard, 28 channels have been catered for on an International basis, intended to meet all normal needs, for shore and ship working. Some channels are limited to working Simplex, others, including those intended for Public Correspondence and continuous Radar Information, provide for working Duplex. To enable simple equipment to be used where necessary, it is the aim to provide certain channels as commonly as possible, in addition to the Safety and Calling and first choice Intership, so that minimum essential port facilities will be available to a ship equipped with only 5 or 6 channels.

**Advantages of the New System.**

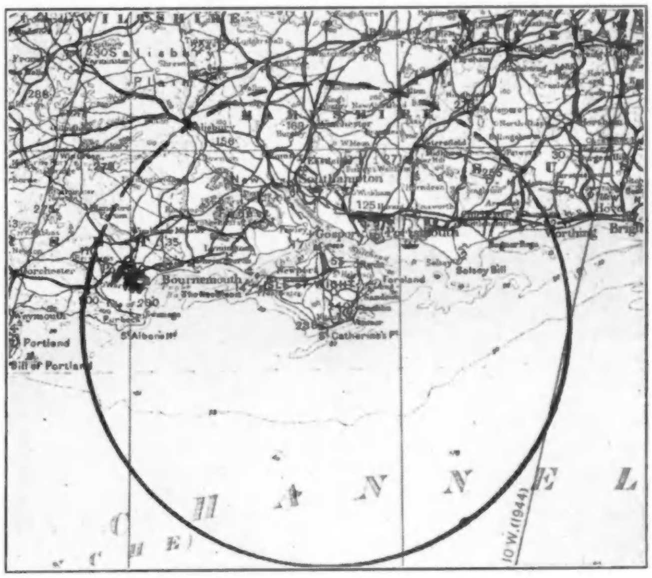
The main advantages of the new system are twofold; firstly, communication is clear and steady and can be compared with a normal telephone connection, secondly, the range of operation is normally limited to some 40 miles or so from the coast station, and something like half that distance between ships, thus obviating interference from stations outside the area, one of the problems, particularly at night, on the existing intermediate 2 Mc/s band. Selection of channel is instantaneous and there is no tuning. Monitoring or "listening out," by means of the bridge loudspeaker, gives a silent background in the absence of a signal. Owing to the "capture" effect of FM, interference between different stations transmitting at the same time is largely avoided, and the nearest station, normally the one being worked, comes through clearly.

A further, indirect advantage, is that congestion on the 2 Mc/s band from short distance communication can be relieved, leaving the band available for long range working and greatly improving conditions on it.

**Public Correspondence and Harbour Stations.**

Two main types of shore facilities are in the course of provision in the U.K.; Post Office stations for Public Correspondence (of which the first, at Rothesay in the Isle of Bute, opened on May 6th, temporarily without the International calling and Distress channel) and Harbour systems for Port Navigation and Docking such as that projected for Southampton. The latter will provide full facilities for Port Operations, including separate channels, permitting Duplex working, for continuous Radar Information, and channels covering the Principal Docks. The Post Office has already announced the first Coast Stations to be equipped for Public Correspondence. These are: Lands End, Niton (Isle of Wight), North Foreland and Humber (Mablethorpe).

As the Southampton Harbour station will commence operations with the International Calling and Safety frequency, it may be the first VHF station in the United Kingdom fully conforming to the principles laid down at the Hague meeting, all the other frequencies employed being those agreed at the Conference.




Estimated service area of the Niton station.

The scheme sponsored by the Southampton Harbour Board is comprehensive and has been drawn up in consultation with the Ministry of Transport and Civil Aviation, the General Post Office, the Liverpool Steamship Owners' Association, the Radio Advisory Service, and others principally concerned with local docking, namely the British Transport Commission, Esso Petroleum Company, Shell Mex and British Petroleum Ltd. Details of the scheme have been given in Southampton Harbour Boards' Preliminary Notice to Mariners No. 22 of 1956 and Notice to Mariners No. 11 of 1957.*

From the communications viewpoint, an important feature of the Southampton Port Operation and Information Service, as the service is known, is that ships and harbour craft will have to be fitted with VHF FM equipment to the new International Standard, if advantage is to be taken of the facilities, including Radar Information. (As a temporary measure, the Post Master General has consented to the use of 2 Mc/s telephony by unequipped vessels for working the Harbour Patrol Launch). It is not the intention of the Southampton Harbour Authorities to provide portable sets to be carried on board by Pilots, and unless ships have their own equipment installed, they will be unable to use the

* A full description of the scheme was given in the September, 1956, issue of this Journal.

## *Maritime VHF Radio Telephone Service—continued*

special navigational facilities, even though a full range of conventional W/T and R/T equipment may be fitted.

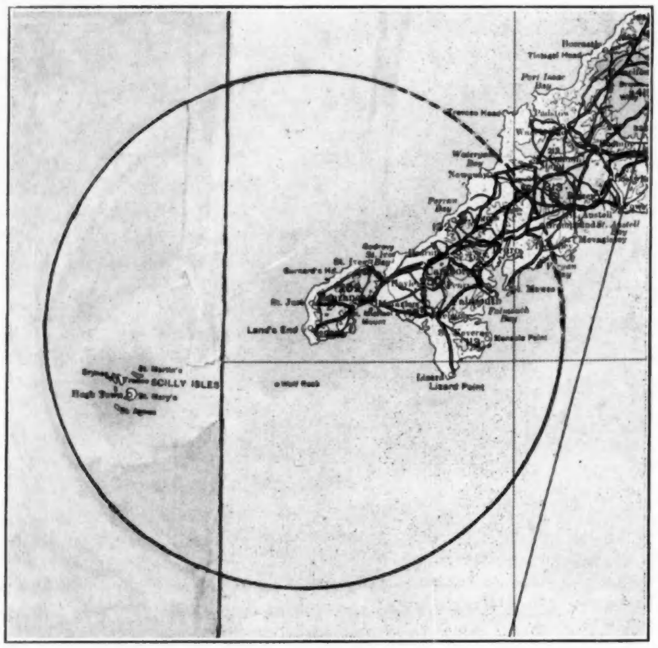
To take account of civil flying boats operating from Southampton waters, provision is being made in the scheme for a Patrol Officer (from the Harbour Patrol Launch) to be stationed on board the Flying Control Launch with a portable set to maintain direct contact with the Port Operations Officers, during flying operations.

A total of 8—9 channels will be involved in the Southampton Plan, including those peculiar to particular Docks. In addition, there will be the Public Correspondence Service from Niton, on further channels, giving access to the public telephone system for ships' business or passenger use.

**Existing National Use of VHF.**

A number of Harbour and Docking Authorities are licensed to use VHF to National Standards and, in addition, in this country as opposed to many others, the Post Office allow private systems to be installed, for example, by tug owners, and a number of channels are at present available on a National basis, for this purpose.

In the United Kingdom, the equipment has been largely Amplitude Modulated and often based on land mobile installations, being designed to a similar technical specification.




Estimated service area of the Lands End station.

The pioneer Liverpool Harbour Radar Information Service uses such a system, and portable sets are available for use by the Pilots, there being insufficient inducement for ship owners to generally fit their own permanent equipment specifically for one port, although a number of ships regularly using the port have found it worthwhile doing so, despite this handicap.

It has already been announced that Liverpool will adopt the new FM system in the future and other authorities are likely to follow suit.

**Overseas Use of VHF.**

Other countries, in providing National VHF Schemes, have been more fortunate in choosing FM, in some cases synonymous or very close to the International Standard, now proposed. Many coast stations have been provided and ships fitted in North America, and in the Great Lakes, through United States and Canadian cooperation, a comprehensive system has been operating for sometime, fully demonstrating the advantages of VHF for high quality short range communications when a network of shore stations has been established and extensive ship fitting has taken place. It is worthy of note that voice communication has now replaced W/T throughout the Great Lakes, telephone equipment on 2 Mc/s and above providing the longer range connections. Direct communication with Locks in addition to normal Port, Intership and Public Correspondence working has been a special and valuable feature. When the remaining bottleneck between Montreal and Prescott in the St. Lawrence Seaway is removed and the existing 14-ft. draught increased to 25-ft., due for completion in 1959, it is to be expected that there will be a big increase in International shipping operating in the Great Lakes, and it will obviously be an advantage for such ships to be equipped with VHF. Over 100 ships on the Great Lakes have already been fitted with VHF FM equipment.

It is hoped to publish, in the near future, an article describing in full the Great Lakes radio telephone system illustrating the considerable benefits it has brought to ships using these ports.

Another part of the world where public schemes have employed FM, is Scandinavia; in the case of Denmark, for example, the Danish State Ferries have, for some years, been fitted with FM equipment, basically similar to that now recommended. In this particular example the ships can be fully integrated with the shore telephone system and a subscriber can dial not only the individual vessels required, but, by dialling further digits, be connected to the particular part of the ship required, e.g., Bridge, or Purser's Office.

In connection with the extensive Radar Information system of the Rotterdam waterway, complete FM coverage has been provided by a number of shore based stations.

Although designed to work with special 12 channel portable sets, with built in loudspeakers, carried by the Pilots, the system is being adapted to conform to the International FM standards and to provide direct communication with ships suitably equipped. Some Dutch liners have already been fitted for this purpose.

In France (e.g. Cherbourg), Germany (e.g. Bremerhaven), and elsewhere in Europe, FM is already in use, and is extending. Lisbon will make use of it in the proposed Harbour Radar Information Service, as also Durban in the Commonwealth.

**Equipment for the New Service.**

Equipment is already available to meet the new International specification. In some cases this is based on the experience gained by Danish and other firms who have already overcome the difficulties of operating in the maritime FM field in much the same way as broadcast set manufacturers gained from the experience of the continent which enjoyed FM broadcasting many years before a public service was established in this country.

The price of equipment will probably range from between £150 to £300 for a small set with a few essential channels, to considerably more for a higher powered set with, say, 16 channels, likely to provide full facilities on a world wide basis and fitted with remote control. Normal rental maintenance terms on a 5 to 7 years basis will be available.

**Conclusion.**

In conclusion, it would appear that, apart from providing an ideal off-shore and harbour radiotelephone service through Public Correspondence stations, VHF FM lends itself particularly to Harbour and Docking operations, enabling full advantage to be taken of Harbour Guidance and other facilities available, with the assurance from the ship owner's point of view that the equipment can be used on an International basis. That the shore facilities will now rapidly extend, cannot be doubted, and ship owners are likely to follow suit, particularly when operating to ports where full navigational and docking assistance is available through the new service.

**Improvements to Inland Waterways.**

British Transport Waterways announced recently that bank protection work, by concrete piling, is to be carried out by direct labour on the Grand Union Canal, the Leeds and Liverpool Canal, at Hartshill on the Coventry Canal and at Hillmorton on the Oxford Canal. A narrow part of the channel of the River Calder near Calder Vale Staithe is to be widened to assist navigation by compartment boats.

# Efficient Lighting at Ports

## Increased Productivity in Docks and Rail Yards

By W. T. SOUTER, F.I.E.S.
(Sales Director, Holophane Ltd.).

THE primary function of docks and railway yards, apart from considerations of passenger traffic, is to handle and despatch freight. Quick and adequate flow of raw materials to the factories and the subsequent expeditious transit of the finished products to home and overseas customers are vital to the well-being of the nation.

But the execution of these levels of activity during daylight must often be carried on during the hours of darkness, and a corollary is that the planning and execution of artificial illumination must command the same careful detail and appraisal of inherent problems.

It is proposed to set out here some of the problems of illuminating docks and railway marshalling yards, and how best they can be solved, and although this article will deal with artificial lighting as an aid to speedier handling of freight, there is also an important need for improved lighting as a protective measure in the interests of safety and to prevent theft.

**Dock Lighting.**

Recent installations have been planned to provide illumination values ranging from 0.25 to 1 lumen/sq. ft. and have proved extremely effective, due in no small measure to the careful consideration given to the avoidance of glare conditions.

In one respect the problems associated with dock lighting are very similar to those pertaining in the street lighting field, in which visibility and the satisfactory adaptation of the eye are directly influenced by discomfort and disability glare.

Normal dock and quayside activities are carried out in areas with static and movable obstructions, and under lower illumination levels than those employed under interior lighting conditions for similar tasks. The efficient working and safety of movement of the operatives can, therefore, be prejudiced by the existence of a few unscreened or badly sited light sources, despite the fact that the illumination levels and uniformity are otherwise satisfactory.

An important further requirement is that the light sources, both in their spectral colour and distribution, cannot interfere with navigational safety.

Consideration must also be given to the docking of vessels at night and the visibility conditions provided for the pilot manoeuvring to approach the dock or quayside is naturally a matter of major importance. Indirect glare reflected from the surface of the water can be a serious distraction, and the screening and siting of light sources to avoid direct and indirect glare from the water approaches provides a further factor in the design of the installation.

**Correct Siting.**

The siting of lighting fittings is usually one of the most difficult problems due to the obstructions afforded by travelling cranes and the impediment peculiar to maritime traffic. The layout of the dock equipment will naturally vary with its size, purpose, and the class of vessels berthed. The method of light distribution employed will be largely dictated by the number and location of siting positions, determined by practical considerations.

In many instances, permissible spacing of columns considerably exceed 100-ft., requiring fittings having spacing height ratios in the order of 3 : 1, and in certain types of docks transporter cranes and auxiliary equipment may necessitate the employment of floodlight projectors mounted at elevated positions at distances of 700 to 1,000-ft. apart.

The first of these two alternative methods has a close resemblance to cut-off street lighting systems, where there is little reflected light from surroundings and the shape of the vertical light distribution curve above 65° will be influenced by characteristics of intensity distribution which alleviate glare conditions.

Cargo carried by cranes requires close observation by dock operatives when in transit between dockside and hold. The height, direction and movement of the load must be judged while being transported in the air, and while the load is usually illuminated by suitable floods on the crane portal, the presence of glare sources may seriously impair satisfactory observation of the cargo, and subsequently, upset the visual adaptation of operatives to quayside illumination levels.

It is thus important to screen the light sources and to avoid direct and reflected glare on the water approaches, and these factors make it very desirable that there shall be a sharp run back of intensity beyond 65°, with a cut-off approximating to 70° from the downward vertical.

These light distribution characteristics necessitate an accurate optical design, which has been achieved with mathematically designed reflectors of a specular or prismatic character with critical light centre positions. The mechanical design and choice of materials must necessarily be suitable to withstand prolonged exposure to severe weather conditions in strong brine atmospheres. Salt water and rain water, polluted by sulphurous smoke from ships, can cause active electrolytic action between dissimilar metals employed in lantern constructions with serious corrosive effects and dangerous reduction of mechanical strength.

To resist these conditions it is necessary to make a careful selection of aluminium alloys having a satisfactory silicon content, cadmium plating of bolts, and provision of weather resisting exterior surface finishes. Vitreous enamel reflectors offer the satisfactory mechanical features of robustness and permanence for exposed situations. Where it is convenient to adopt a mounting height and spacing which does not materially exceed 2 : 1, dispersive type vitreous enamel reflectors can be used to advantage.

**Crane Lighting.**

It is imperative that both crane driver and quay worker should be able to see the load and empty crane hook at all times; there must be absence of glare to both; and the interior of the crane cabin should be illuminated. In fulfilling these requirements, however, it is rarely possible completely to satisfy the driver without prejudice to the quay worker, or vice versa.

Careful sighting of controlled directional lighting at night is imperative for instant recognition of obstructions such as travellng cranes, bollards and recessed rail lines so familiar in this daylight view.

## *Efficient Lighting at Ports—continued*

Adequate standards of quay and ship illumination will reveal the load at the lower heights in the course of its passage, but supplementary localised lighting is usually required when the load is lifted above the general lighting field. Cargo cluster fittings or floodlights attached to the jib, or angle reflectors mounted below the crane cabin, are normally employed, depending on the type of crane and its effective range of operation.

Scoop type fittings mounted on the portal of travelling cranes can be used to advantage for lighting the load and providing additional local illumination of the quayside at the points of greatest activity.

**High Level Floodlighting.**

Ship repair quays and many others possessing mechanical equipment and transporter cranes preclude the use of even a limited number of lamp columns, and high level floodlighting provides the only practicable alternative.

Mounting heights of 50-ft. or greater are employed in order to remove light sources as far as possible above the normal sight lines of dock operatives, and the position, type and training of the floods are necessarily dictated by the layout of the quays concerned. Long narrow quays with berths on each side have been illuminated satisfactorily with 1,000 w. concentrating floods having a beam divergence of 15°—20°, mounted on towers at each end and trained longitudinally along the quay.

Single berth quays of sufficient depth have been floodlit by banks of units arranged on towers at the back of the quay, projected towards the quay edge with an effective cut-off at that point. In such cases, the use of horizontal discharge lamps, both mercury and sodium, have been employed successfully with asymmetric reflector fittings, the high lumen per watt efficiency of these lamps, and the inherent light distribution characteristics of these horizontal line sources particularly lending themselves to the efficient controlled distribution required.

Overall costs of providing 50-ft. towers or steel columns, including cabling, compares favourably with the installation charges for a general lighting scheme involving a much greater number of columns and lanterns which are more vulnerable to damage and most costly to maintain.

**Railway Sidings.**

It is a fundamental requirement, in the interests of safety for the operatives, that obstructions between railway tracks be reduced to a minimum. This limitation frequently determines the method of lighting to be adopted as the permissible number of siting positions may well dictate floodlighting treatment, particularly in marshalling yards where the space between the parallel roads is insufficient for the erection of columns without danger of obstruction.

In these long narrow alleys between lines of rolling stock, the shunters must have adequate visibility to operate with safety and confidence. Furthermore, the positions of the points at the shunting neck must be clearly seen, so that trucks are efficiently despatched down their correct road. They must also be able to judge that trucks have effectively cleared the road which they have just left. This is particularly important in yards employing "Hump-Back" shunting, where the points are operated remotely by a controller in a tower.

Where sidings are located next to running lines the siting, directional intensity and colour quality of any of the yard lighting units must not interfere with visibility and correct interpretation of railway signals.

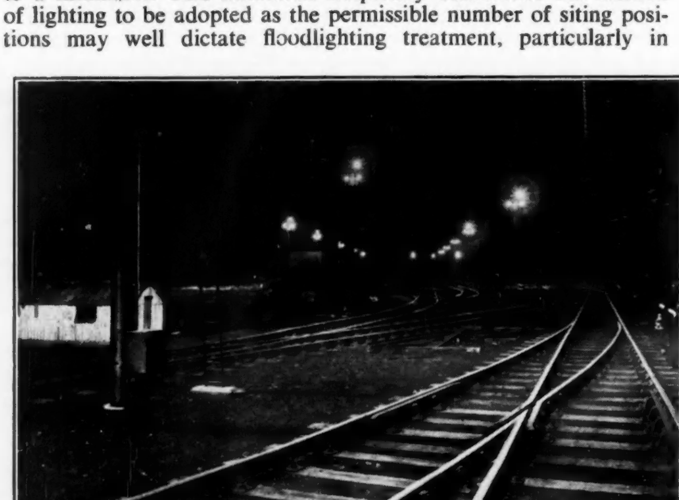
Taken in conjunction with the practical and economic factors associated with the treatment of large areas, these considerations have led to the increasing adoption of powerful long-range floodlights, mounted in groups on tall columns or towers. Mounting heights of 50-ft. and even 150-ft. have been employed with very effective results. Increased mounting height not only reduces glare, but also materially reduces the shadow factor, particularly in the alleyway between parallel rows of wagons.

Columns or towers are installed at the end of a block of sidings at approximately 50-ft. intervals, equivalent to the spacing of three or four tracks. The floodlight beams are trained parallel to the tracks, providing illumination between the roads up to distances of approximately 500-ft., on the basis of suitable 1,000 w. projectors at a minimum height of 50-ft. In practice, most yards exceed this distance, and further transverse lines of columns become necessary to cover the additional length of the track. These intermediate columns can usually be equipped with projectors trained in opposite directions, reducing the number of columns required, with convenience of maintenance.

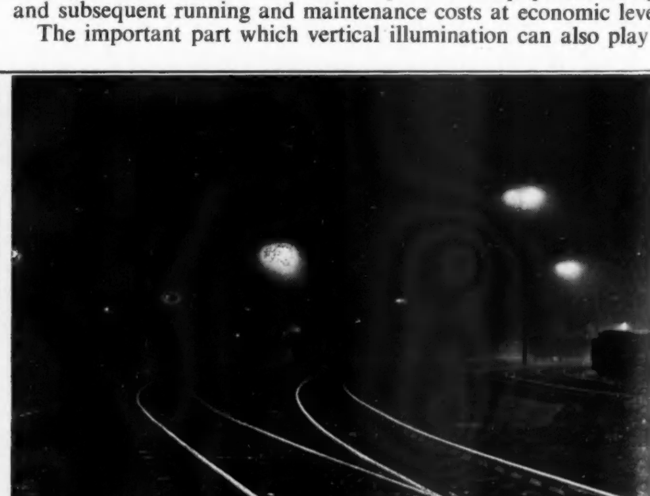
This arrangement allows spacings of 1,000—1,200-ft. between adjacent transverse rows of floodlight columns in yards where floodlighting in both directions can be employed, but in "Hump-Back" sidings uni-directional floodlighting is desirable in the interests of maximum visibility in the preferred direction of view.

An average horizontal illumination value of 0.25 lumen/sq. ft. with additional local lighting at key positions, is commonly adopted as providing a reasonable standard of visibility in carefully planned installations. This keeps initial equipment charges and subsequent running and maintenance costs at economic levels.

The important part which vertical illumination can also play in



A good example of sidings lighting. The floodlights, equipped with prismatic lenses are mounted on 50-ft. steel columns, spaced 450-ft. apart. Note the effective illumination defining rails and points.



Refractor Bowl lanterns with 400 w. mercury discharge lamps in clusters of three. Mounting height is 60-ft., columns spaced 300-ft. apart.

## *Efficient Lighting at Ports—continued*

promoting good visibility and revealing power in both railway yard and dock area must not be ignored. Consideration of the equipment and obstructions common to both of these industrial plants will serve to confirm that vertical surfaces are closely related to their identification.

Floodlight projection over distances of 500-ft. will naturally afford low horizontal illumination at the more distant points owing to the oblique angle of incidence, but the vertical illumination will be considerably higher, being almost normal to the axis of the beam. The characteristics of this form of light distribution also tend to provide a background brightness against which dark objects, having a negligible reflection factor, can be revealed in silhouette, and specular reflection from the traffic polished surface of the rails makes them clearly discernible over considerable distances.

This technique, employing high beam angle distribution, can be applied to advantage with high level mounting street lighting refractor lanterns in railway yards where the general layout and diverse activities preclude the adoption of floodlighting methods.

Yards of main-line termini frequently present a complicated network of tracks fanning out in all directions and fulfilling many different functions. Goods loading and unloading, carriage cleaning, locomotive yards, passenger train and goods train marshalling yards and coal bunkering, are some of the many activities essential to efficient round-the-clock time schedule traffic operations. Here the movement of rolling stock and operatives in a congested area is fairly continuous, and the reduction of shadows to a minimum is as important as the provision of adequate illumination. Moreover, these areas are frequently enveloped in a heavy pall of smoke and steam created by engines in the loco-yard, with the result that the atmospheric absorption and obstruction of the artificial lighting are extremely heavy. Under these conditions, long range floodlight projection would be quite inadmissible owing to the dense and variable character of the shadows caused by concentrated clouds of smoke and steam, the movement and dispersion of which is entirely dependent upon climatic conditions.

A satisfactory solution to these requirements has been achieved by the adoption of 400 w. mercury discharge refractor bowl lanterns, arranged in clusters of three on 60-ft. columns, spaced at approximately 300-ft. centres. The refractor bowl lanterns are of the type normally employed for street lighting, providing a symmetrical distribution with the peak beam angle at 78°. The lanterns are effectively sealed against the ingress of moisture and atmospheric pollution common to these situations. With this arrangement an average illumination of 0.25 sq. ft. is obtained at ground level with reasonably satisfactory diversity and shadow factor.

A noticeable feature of this type of installation is the impression of space lighting, which has been likened to full moonlight, possibly due to the absorption and reflection of light by moisture and dust particles which are present in a fairly concentrated form in the atmosphere.

The general effect of diffused atmospheric brightness and good background illumination has proved of great value in simulating comfortable seeing conditions in which operatives can move with confidence and with a greater measure of safety. A general lighting scheme of this nature also greatly improves yard supervision by the railway police, and experience with such installations has shown a marked reduction in pilfering. In those areas which are in close proximity to running lines and signals, 1,000 watt tungsten lamps are employed, but wherever possible advantage is taken of the high lumen output efficiency of the mercury discharge lamps.

**Future Developments.**

It is now apparent that the trend of installation design is towards the adoption of grouped fittings with powerful light sources, with high level mounting, at a limited number of site positions, whether the method employed be the adoption of directional floodlighting equipment, or fittings providing symmetrical light distributions. While the initial costs of such lighting equipment and columns or towers may be high, the reduction in cabling is quite appreciable, and the subsequent operating advantages more than justify the first costs.

Typical dock lighting scene planned to provide adequate directional illumination by prismatic reflectors without harassing glare.

In this connection, reference can be made to the recent introduction of a new 1,000 w. mercury discharge lamp, having a light output equivalent to three tungsten filament lamps of similar rating, which has been successfully employed for high level floodlighting on railway sidings. This development provides a further indication of the future trend and the active contribution which is being made by the lighting industry on a subject of vital importance to the national welfare.

The higher lumen efficiency of the larger tungsten and mercury discharge lamps effects an economy in running charges, and maintenance at regular intervals is encouraged by the grouping of units at relatively few positions remote from the working area. High level mounting eliminates the accidental damage and breakage of fittings and lamps which frequently occurs when they are installed at lower levels within the working area. Furthermore, the larger size of fitting lends itself more readily to the design of robust weatherproof construction with greater immunity from corrosion, and improved handling facilities for maintenance.

It will thus be seen that the measures which are being taken to speed up the handling and despatching of freight, by increasing use of controlled artificial illumination, amply justifies the initial costs of installation.

Improved lighting means increased efficiency and safety, assuring quicker "turn-round" with long-term reduction in running costs. And an important factor not to be overlooked is the added protective measure gained; night supervision duties of dock and railway police are made far more effective.

**Increased Facilities at U.K. Oil Terminals.**

Work is now in progress on the extension of the ocean terminal at Finnart, Loch Long, which, when completed, will be able to accommodate oil tankers of up to 100,000 tons deadweight. It is estimated that, within the next two years, the handling capacity of the refinery at Grangemouth will be raised from 2 million to 3 million tons of crude oil per year.

It has also been announced that Southampton Harbour Board has approved a dredging scheme which will enable tankers of 65,000 tons deadweight to be handled at Fawley Marine Terminal. The approach jetties will be deepened and a deep trench dredged at the new No. 5 berth. The Harbour Board is very much aware of the possibilities and problems arising from the building of large tankers and experiments are being carried out at Southampton University with a tidal model of Southampton Water and approaches to find the effect on the tidal stream of the dredging that might be needed for future developments. Further experiments are being carried out at the National Physical Laboratory to test how the largest tankers would behave when manoeuvring in narrow waters. It is hoped that all these experiments will give the answer to some of the problems likely to be met in the next few years.

# The Ring Dolphin

## Structural and Installation Details

The dolphin has been designed for use in connection with the handling of large ships in ports and harbours or other marine terminals. It is a buoyant and movable device with a large energy absorption capacity. The dolphin may be used for berthing and mooring and for such purposes as the guiding of ships in narrow entrances where wind or current may present a navigational hazard.

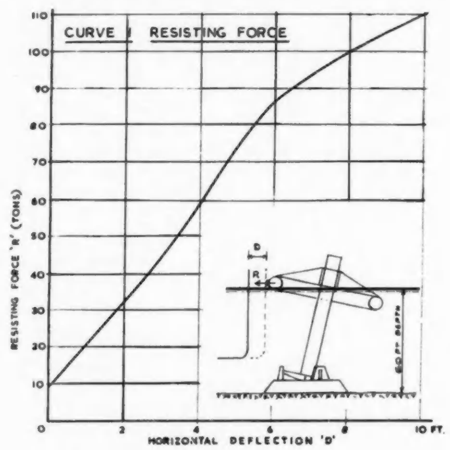
Scale model tests in water have been carried out on a dolphin at the National Physical Laboratory, Teddington, London, and the results will shortly be published.

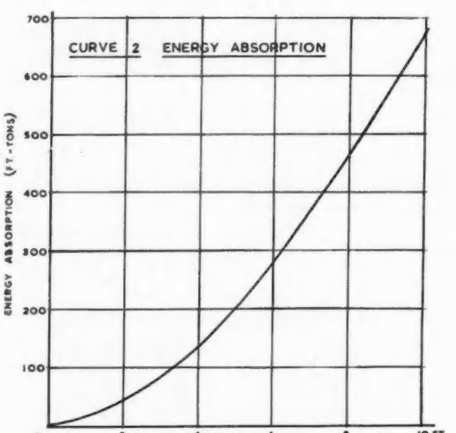
**Principle of Action.**

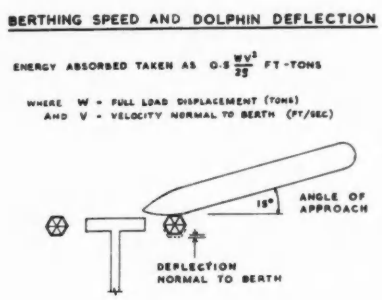
The design consists of three main structural elements — a hexagonal floating pontoon, a hollow, buoyant shaft and a concrete base. When in position the dolphin is anchored by the base resting on the sea bed; the lower end of the shaft has protruding arms which engage loosely in recesses in the base and bear upwards against them. The shaft is enclosed by a collar attached to the pontoon, and the pontoon is free to move up and down the column according to the state of the tide.

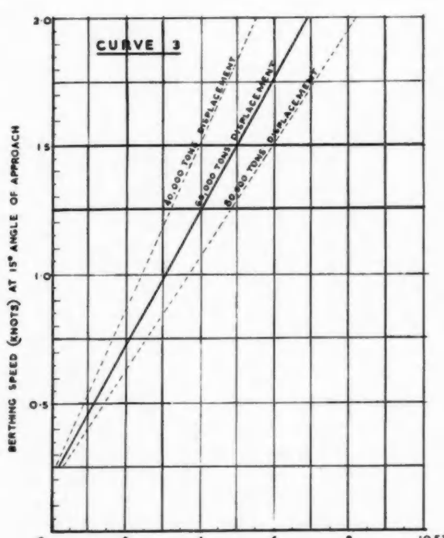
The buoyancy of the column is sufficient to keep the dolphin more or less vertical against the forces of current or wave action, but the direct force of ship's hull on the pontoon causes the collar to bind on the column and the dolphin heels over; buoyancy forces come into play and the kinetic energy of the moving vessel is absorbed. The deflection of the column from its normal vertical position causes one of the arms at its base to move out of contact with its bearing surface. The structure therefore pivots about the extremities of the remaining arm giving an increased arm to the righting forces and hence a high value of righting moment.

The righting moment of the dolphin increases rapidly as the structure heels over. The buoyancy of the column (and therefore its righting moment) will be a minimum at low tide and a maximum at high tide. On the other hand, the depression of the pontoon will be more rapid in the low tide position because of the shorter radius of movement and thus its righting moment is greater at low tide than at high tide. In this way, the resistance due to the buoyancy of the column and of the pontoon tend to compensate each other, and the efficiency of the dolphin with regard to the absorption of energy may in some circumstances be approximately the same at all states of the tide.




**Range of Usage.**

The present design is intended to work in 60-ft. depth of water with a tidal range up to 15-ft. It embodies mooring and refuelling devices, but is primarily intended as an energy-absorbing dolphin. In this respect the blow from a 60,000 ton ship berthing at a speed of 1 knot and at an angle of 15° would deflect the dolphin somewhat less than 5-ft.

Alternatively, when used as a mooring dolphin, it can resist a pull of at least 100 tons without sliding on the sea bed. Thus if a large tanker were moored to 3 dolphins they could effectually hold the ship in position in conditions of gale force.

The above figures are conservative, and take no account of the proportion of energy absorbed by the ship's structure when the vessel strikes the dolphin, nor of the "dash-pot" effect of the sea water when the dolphin is suddenly deflected. The energy absorbed in moving the dolphin's own mass about its centre of rotation has also been neglected.

**Curve 1** (see Graphs) shows how the horizontal resisting force develops as the dolphin is deflected. After the limit of 10-ft. deflection is passed the base will tend to be lifted from the sea bed and the dolphin will drag.

**Curve 2** shows the amount of energy absorbed as the dolphin is deflected. At 10-ft. deflection, which may be considered the limit, this reaches the value of about 700-ft.-tons.

**Curve 3** shows a comparison of the deflection of the dolphin for various berthing speeds and sizes of ships. In this instance an allowance has been made for an absorption of energy at impact by the deformation of the ship's hull, etc., and the energy absorbed by the dolphin has been taken as 50 per cent. of the total kinetic energy of the vessel. It will be seen that a tanker of 60,000 tons displacement, berthing at a speed as high as 2 knots, deflects the dolphin approximately 7-ft. for the given angle of approach of 15°.

**Structural Details** (see Figs. 1—3).

The dolphin consists primarily of a concrete base, centre column and floating pontoon. The action of this type of structure has already been described and only a brief description of the form of the present design is given here.

The pontoon is a hexagonal ring formed of cylindrical shells made up from steel plates stiffened internally. This hexagonal pontoon is attached to a collar enclosing the centre column and is free to move vertically up and down the column according to the state of the tide. The members joining the pontoon to the collar are steel tubes welded at the joints. The collar also is built up from tubes and is stiffened by gusset plates. The pontoon carries fenders at the corners and has a level walkway.

The centre column is also a hollow steel cylinder, carrying three projecting arms at its lower end. These arms engage loosely in recesses in the base. The column is flat-topped and carries a Bean bollard and may carry an oil pipe connection or connections.

## *The Ring Dolphin—continued*

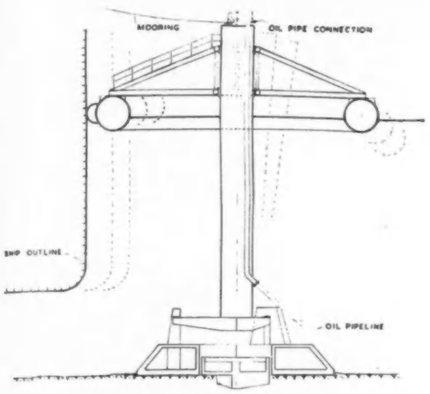



FIG. 1 SECTIONAL ELEVATION

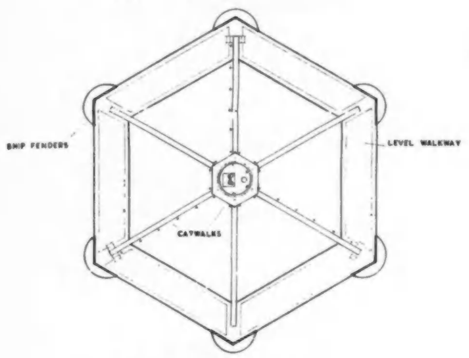



FIG. 2 PLAN VIEW OF FLOAT

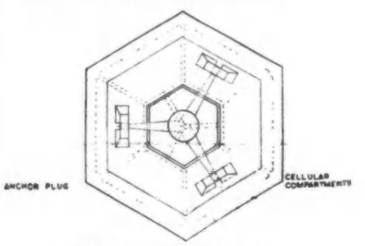
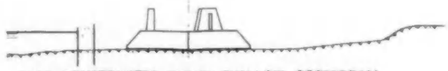



FIG. 3 PLAN VIEW OF BASE

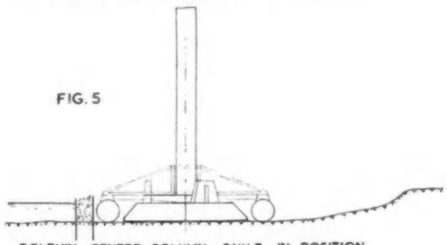
CONSTRUCTION AND INSTALLATION

FIG. 4



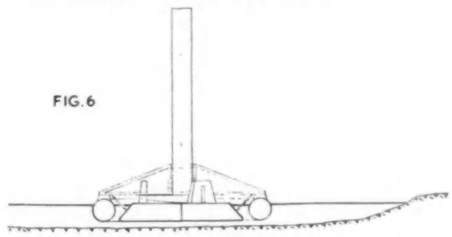
BASE CONSTRUCTED WITHIN SHALLOW COFFERDAM
ANCHOR PLUG RETRACTED AT THIS STAGE

FIG. 5



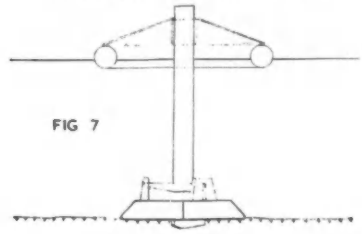
DOLPHIN CENTRE COLUMN BUILT IN POSITION
HEXAGONAL FLOAT ASSEMBLED ON GROUND

FIG. 6



COFFERDAM REMOVED : DOLPHIN FLOATS
TOWED TO SEA POSITION AT HIGH TIDE

FIG. 7



ANCHOR PLUG LOWERED IN BASE
BASE FLOODED AND LOWERED TO SEA BED

PROPOSED APPLICATIONS

FIG. 8

SHIP MOORED TO DOLPHINS REMOTE FROM JETTY
DOLPHIN CARRIES PIPELINE AS REQUIRED

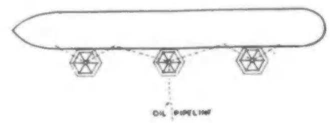



FIG. 9

DOLPHINS AS GUIDES AT DOCK ENTRANCES, ETC.

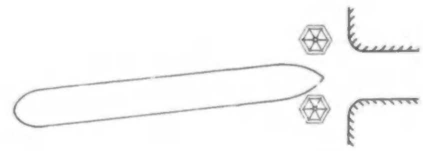
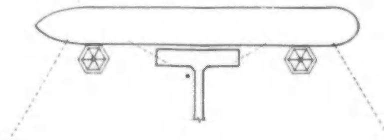
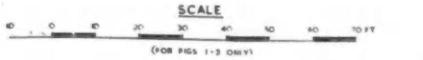


FIG. 10

DOLPHINS ASSIST IN BERTHING
SHIP MOORED INDEPENDENTLY
PIPELINES, ETC. CARRIED BY JETTY HEAD



SCALE




This connection (or connections) join to a pipe within the column which makes its exit some height above the base, and which is connected to a flexible pipeline. Access to the mooring bollard is by way of catwalks along the radial members attaching the pontoon to the collar and thence by footholds set in the wall of the column. These foot-and-hand-holds are accessible at any state of the tide and in any position of the pontoon.

The concrete base is hexagonal and contains cellular compartments which may be air-filled to assist in floating or flooded when the base has to be sunk to the sea bed. To prevent sliding taking place a grip of the bottom may be supplied by a cellular concrete plug provided with keels. Before the base is lowered to the sea bed, the plug is lowered within the base so that the keels project downwards 3-ft. beyond the underside of the base; the whole arrangement is then lowered to the bottom and the weight of the base drives the plug keels into the sea bed. This plug can be bored vertically so that piles may be driven down through it for permanent fixing if this is desired.

**Construction and Installation** (see Figs. 4—7).

The method shown requires a site with a depth of water of about 7 or 8-ft. at high tide, and the beach should be mainly flat or gently shelving.

It is proposed to build a low bank or cofferdam on the shore to enclose an area about 100-ft. x 100-ft. The base, pontoon and centre column would then be constructed "in the dry" on the ground within the cofferdam.

On completion of these members, the pontoon would be attached to the base by chains or ties such that the base is lifted by the pontoon when water is admitted to the cofferdam. The base is designed to supply part of the buoyancy required through its cellular compartments, which would be air-filled at this stage.

The buoyancy of pontoon and base is such that the whole assembly would float in 6½-ft. of water. Once afloat it can be towed out to the required position in deep water.

The base would then be progressively flooded and lowered off from the pontoon until it rested on the sea bed.

**Materials in Structure.**

The design shown incorporates about 110 tons of structural steel, and about 210 cubic yards of reinforced concrete in the base.

These quantities refer to a dolphin which would be installed in 60-ft. of water. The cost of such a dolphin would necessarily depend on its required location. The quantities represent a design which would cater for large berthing forces or gale conditions. More favourable conditions would make for a lighter and less expensive structure.

**Moving of the Dolphin.**

The dolphin may be re-positioned or brought in-shore for maintenance by the reverse process to that used for installation. In such a case it would be necessary to secure the base to the pontoon, blow air into

## *The Ring Dolphin—continued*

the base structure and lift it until the whole assembly floated, with the base raised finally to a position within the annular pontoon. The dolphin could then be towed to its new position or ashore

**General Considerations.**

The dolphin is not only intended as a device for protecting marine structures, but its function is also to protect the vessel while coming alongside to a greater degree than is often the case.

It will be evident that the type of dolphin described may be installed even in conditions where the sea bed is of low bearing capacity.

The design is intended to allow for flexibility in use and also to cater for various local conditions such as the nature of the sea bed and tidal range.

The drawing indicates that the dolphin may be assembled on shore in a cofferdam or bunded enclosure. Equally, however, the dolphin could be built on slipways or it could be built on a staging and lowered by means of wedges or jacks.

In the majority of cases there might be no need for, or intention of using a dolphin in more than one location. In such cases the construction of the base could be simplified as there would be no necessity for closed buoyancy chambers. The tubular shaft and hexagonal pontoon structure can be readily detached from the concrete base and floated in-shore for maintenance, if necessary.

The approximate quantities of materials given refer particularly to the case of dolphins in 60-ft. of water. It will be evident, however, that protective dolphins at a jetty head in-shore which might well be in shallow water would be somewhat smaller in all respects.

It is understood that there may sometimes be difficulties and delays where tankers are anchored off-shore for the purpose of discharging through submarine pipelines. The proposed dolphins might be used to give a more positive anchorage. The dolphin also presents one method of making one or more pipelines easily accessible.

Finally, where a fixed dolphin might not escape damage or might cause damage to a vessel in exceptionally severe conditions, this dolphin would merely be displaced and the vessel would not necessarily be damaged. The base will tend to tilt and slide if the dolphin is subjected to excessive lateral force.

Figs. 8—10 illustrate some possible applications for the use of this type of dolphin.

# Fire Fighting in Ports

## International Standardisation Required

By FRANK RUSHBROOK, M.I.Fire E.
(Chief Fire Officer, County Borough of East Ham Fire Brigade).

WHILST from time to time a major fire develops on board a ship in a British Port resulting in a total or serious loss it must be admitted that by and large such incidents are comparatively rare. The credit for this state of affairs belongs, not only to the care taken by those who sail and manage the ships, but to the Port Authorities who lay down safety regulations governing the prevention of fire on board vessels using their dock facilities, national legislation governing construction and the provision of adequate fire fighting equipment and last, but by no means least, the men of the British Fire Service who, by their constant devotion to duty, succeed in keeping so many fires in the "small" category. Large fires are news, small fires are not!

The fact that the number of fires is not high does not in any way mean that the nation can be complacent with regard to the prevention of fire on ships. The far reaching effect of a fire resulting in the total loss of a vessel is undisputed and by no means ends with the capital cost of replacement. A ship destroyed by fire in dock, particularly if she has capsized, is a tremendous liability on the Port Authority. Not only will be berth be lost for many months but the actual cost of salvage will outweigh the scrap value of the ship. From the nation's point of view the loss of earning capacity of the vessel has far reaching effect on our economy.

The consequential loss following fire can well be illustrated by the recent fire in a signal box at Cannon Street Railway Station in London. The actual monetary loss was small, certainly under £20,000, but the effect upon the public was very far reaching—only six trains were allowed in and out per hour during daylight—less than half the normal amount. Only two out of eight platforms were in use and no steam trains were allowed into the station. The impact upon the travelling public can well be imagined and this state of affairs lasted for a full month. These hidden fire losses are common in most fires and certainly are present in the case of shipboard fires.

The "bible" of the British Shipping Industry is the Merchant Shipping (Construction) Rules, 1952—Statutory Instrument 1952 No. 1948. Apart from general construction this deals with such things as means of closing and operating doors covering openings in watertight bulkheads; protection of stairways, lifts and vertical trunks for air and light; the fitting of draught-stops in air spaces behind ceilings and panels; fire resisting wall lining; slow burning paints, varnishes and similar preparations; the fitting of automatic fire alarm and fire detection systems; automatic sprinkler systems; and the provision of adequate means of escape in case of fire.

The internal protection of the vessel against fire is laid down in the Merchant Shipping (Fire Appliances) Rules, 1952. These rules are international in scope and embrace some 47 countries who are signatories to the 1948 Safety Convention. The Rules are extremely comprehensive and cover fire patrols; alarm and detecting systems; fire pumps; portable and non-portable fire extinguishers; protection of holds by permanent piping system whereby fire-smothering gas can be rapidly conveyed to the seat of a fire; a suitable number of fire hydrants complete with hose and directing nozzles; the provision of firemen's outfits consisting of breathing apparatus; fireman's axe and safety lamp; and the means of rapidly stopping all fans and closing all openings which might admit air to spaces provided with a piping system for the discharge of smothering gas, etc., etc.

The Fire Services Act. 1947, is the statute which governs the operation of the British Fire Service. Under this Act, Section 39 (3) the senior Fire Brigade Officer present has the sole charge and control of all operations for the extinction of fire. This factor has been a matter of some concern to a number of persons connected with the shipping companies and with some Port Authorities. The 1949 Working Party on "Fire Prevention and Fire Fighting in Ships in Port" (Paragraph 32) were strongly of the opinion that the consequence of endangering a ship's stability through the intake of large quantities of water were so grave and raised issues so far beyond the competence of the Fire Service accurately to assess that the decision to stop pumping in order to prevent capsizing or to allow a ship to be moved away must always rest with the appropriate dock or harbour authority. In 1950, The Secretary of State issued a Fire Service Circular No. 4/1950 advising Local Authorities to give instructions to their Chief Fire Officers in conformity with paragraph 32 of the Report.

There is no doubt that Chief Fire Officers are deeply conscious of the need for the closest liaison between the shipping companies and Harbour Masters, and would always accept advice on the important matter of a ship's stability. This section of the Working Party's report only emphasises what is recommended in another part of that report, that the closest possible liaison should exist between the Fire Brigade on one hand and the Dock Autho-

## *Fire Fighting in Ports—continued*

rity, shipowners (or Managers) and ship repairers (or builders) on the other. It is imperative that the Senior Fire Brigade Officers should regularly meet and be on friendly terms with the Harbour Masters, Shore Superintendents representing the various shipping companies and the senior officers on the major vessels regularly using the port covered by the Fire Brigade in question. It is only through this knowledge that a really efficient liaison is maintained during fire fighting operations. Each officer already knows his counterpart and will have, it is hoped, learned to respect each other's particular problems and point of view.

Not only must the Senior Officers meet and get to know one another, the rank and file of the Fire Brigades must also be allowed on board the ships so as to gain a working knowledge of the topography of all major types of vessels using their port. A large passenger ship has been likened to an hotel, a cinema and a pleasure pier superimposed on a very large cargo ship and that is a most apt description.


Serious outbreak of fire at an American port.

It is difficult for someone who has never had the experience of attempting to breathe and move in thick smoke in surroundings which are completely strange, to appreciate just what a fireman's job entails. It is a fact that ships officers on taking over a new ship spend quite a lot of their time getting to know the layout of the vessel and incidentally on odd occasions getting lost in the process. This being true, imagine the same ship blacked out by thick smoke and try to picture the fireman trying to fight his way to the seat of the fire. The closest possible liaison must exist so that firemen from the local station can get to know the " ins " and " outs " of all the main ships, know the companion ways; the lift shafts; galleys; the various decks and the accommodation to be found at each level; the means of escape from each level; the chain locker and paint store; the engine room with position of settling tanks; the access to bilges, tunnel shaft access; baggage and store rooms; the holds and the thousand and one places on board a large passenger ship. Where such a happy liaison exists the possibility of a fire occurring which would result in a " burn out " must be substantially reduced. Such liaison does, of course, exist between the fire service and very many shipping companies but there are the few companies who are not very enthusiastic about this subject. Such people, unfortunately, wait for their " row of corpses " before taking any initiative.

The Masters of foreign ships using British Ports would be acting in their best interests if they would invite the local Fire Brigade to visit their ship when in Port. British Masters should, of course, do the same when visiting foreign ports. The British Fire Service is deeply conscious of its responsibilities with regard to the protection of ships in British ports and indeed are prepared to go to sea to fight fire. One go ahead Brigade has even experimented with helicopters for the purpose of taking equipment and personnel to the stricken vessel.

Under Section 1 (1) (f) of the Fire Services Act, 1947, it is the duty of each fire authority in Great Britain to make efficient arrangements for giving, when requested, advice in respect of buildings and other property in the area of the fire authority as to fire prevention, restricting the spread of fires, and means of escape in case of fire. Applications for advice on any matters pertaining to fire will be readily given by any of the Fire Brigades in Britain who have highly skilled Fire Prevention Officers at their disposal.

Recently a questionnaire on fire prevention at ports was sent to thirteen of the principal ports of Great Britain, and the standard questions, together with a summary of the answers given, are shown below.

**Question 1. Do the Port Authority, as distinct from the Fire Authority, provide any fire fighting cover for the Dock area?**

Only one Port Authority provides any fire fighting cover. all the others rely entirely upon the local authority fire brigades.

**Question 2. Do the Port Authority provide a Fire Prevention Officer? If so (a) what are his general duties? (b) does he have the statutory power? If not, (c) does the Fire Brigade Fire Prevention Officer advise on general fire prevention measures, including hazardous cargoes being worked?**

Six out of the thirteen authorities employ one or more fire prevention officers to look after their interests in the port. Rather surprisingly, the Port of London Authority do not employ a fire prevention officer but, of course, they employ as consultants the Fire Office's Committee. The fact that such a large authority as the P.L.A. do not employ such an officer reflects that the management must consider they are well served by the local authority brigades in the area.

**Question 3. Provision of Hydrants. Are the hydrants in the dock area owned by the Port Authority or the Local Authority and who is responsible for maintenance?**

Most hydrants in port areas are owned by the Authorities. Standardisation of outlets is essential for maximum efficiency and it is to be hoped that those authorities who have not yet completed their programme will do so as soon as possible.

**Question 4. Is there an automatic or manual fire alarm system available in the Docks? If not, what is the distribution of exchange telephones in the Dock area, e.g., is every important berth fitted out with a telephone line?**

It is remarkable that eight authorities have not yet installed a fire alarm system in their ports. Exchange telephones whilst normally very reliable do break down at regular intervals, particularly where the phones are installed in Kiosks and are used extensively by dock workers. Another important consideration is that most foreign seamen are precluded from using a telephone through language difficulties, but could easily operate a fire alarm. The installation of an adequate fire alarm system connected direct to the nearest fire station would appear to be a basic necessity in the protection of a port.

## *Fire Fighting in Ports—continued*

**Question 5. Are Brigades notified of the arrival and departure of all important vessels in the Port and also of the nature of any hazardous cargoes?**

Most Brigades appear to be notified of the movement of vessels in their ports and it is considered that this information is essential if the Fire Brigade is to conduct visits to ships at regular intervals.

**Question 6. Details of the Fire Brigade's first attendance into the Dock Area?**

This question relates to the numbers of Fire Brigade appliances sent initially to fire calls in dock areas.

**Question 7. How often, if at all, is the Brigade asked to make comments on the actual design of new tonnage with regard to fire safety?**

The replies to this question are really most remarkable! Only in two cases are the fire authorities **ever** asked for advice or comment on the actual design of new tonnage with regard to fire safety and in the two cases only infrequently.

Has the great British Fire Service—often quoted by impartial foreign observers to be the finest in the world—nothing to offer the shipping industry in connection with the protection of new vessels? The writer has seen many undesirable fire prevention features on board fairly new ships which could easily have been avoided if the Fire Service had been consulted at the design stage. To quote but two examples—a valve to shut off the supply from the settling tanks in an emergency was placed high up in the engine room in a position where a fire below would render the valve impossible to reach; the second example concerning the provision of foam extinguishers to protect the crew's quarters, these being the wrong type for this risk but being installed simply to comply with the Safety Rules.

Surely the men who fight the fires on ships and who can draw on a great deal of practical experience of actually swallowing smoke have useful observations to make which can benefit both the shipping world and the Fire Service. The days of the tough old " shellback " type of fireman has gone and his place has been taken by men who can only reach the top positions after having passed the necessary statutory examinations. More co-operation between the two services could only result in improvement in ship design as regards fire prevention and fire fighting. The great factor of importance is that the fire officer has no pecuniary interest in any particular piece of equipment and can therefore offer unbiassed advice, which manufacturers of fire equipment might find difficult to do.

**Question 8. What internal arrangements are made in Dock in connection with the use of cutting and welding apparatus?**

The Working Party's recommendations regarding precautions to be taken whilst cutting and welding do appear to have been fully implemented in all Ports.

**Question 9. Any other comments?**

From the observations made it appears that co-operation between the Port Authorities and the Fire Service is of a high order.

There is a crying need for international agreement to control the lettering or naming of decks. There are an astounding number of variations of names of decks on board different Companies' ships, the following being only a selection: Hurricane, Weather, orlop, promenade, boat decks, lounge, upper, lower and main deck. To make matters worse, some Companies letter their decks " A " to " E " commencing at the upper deck, whilst others make " E " the upper and " A " the lower deck. This can be most misleading to fire officers going on board a ship to answer a fire call on the information that the incident is on " A " deck as they probably will not know whether to proceed to the upper or lower part of the vessel. It is admitted that Companies who maintain a full watching system would have a guide ready at the gangway to lead the firemen to the scene, but unfortunately this happy state of affairs does not always prevail, particularly when the vessel is in dry dock. Another complication is that supporting fire appliances forming the first attendance arrive at different times, perhaps a minute or so behind the first machine and there is no one to lead them to the scene of the fire. The layman does not always realise that quite a serious fire can be raging on a ship without the seat of the fire being obvious to the watcher on the quayside. Even within a single Shipping Company, variations in the naming or lettering of decks can be found and it would appear that the shipbuilders themselves name or letter the decks according to their local practice. International Safety Rules have been drawn up and agreed by many nations and it does not seem unreasonable to hope that such a happy arrangement can apply to the production of standard nomenclature for lettering or naming of ship's decks!

The standardisation of fire couplings is another field in which international agreement would be welcomed by fire officers throughout the world. The variation of types of fire couplings to be found on board ship is always a source of wonder to the fire officer, instantaneous couplings, hermophrodite, screw thread, round thread, bayonet, lugged, clip, plug-type and wheel type of outlet, to mention but a few. Before the British Fire Service adopted a standard round thread outlet for use throughout the country there were no fewer than fifty types of outlets in service. It must be obvious to the layman that in the interests of efficiency the standardisation of such basic equipment as hydrant outlets is of paramount importance. It matters little whether the fire pump is of British, French or Japanese manufacture; what is important is that British, French or Japanese firemen can all " get to work " from the ship's deck main outlets without having to produce the necessary adaptors to fit a multitude of differently designed outlets.

The problems associated with being able to move a vessel quickly from the quayside, by virtue of a fire in a dockside warehouse, or from an adjoining ship, is one that would stand investigation by an international body. Particularly when a fire occurs at night and skilled personnel are not available, delays of over half an hour can be expected before the ship can be moved.

There are, of course, forms of quick release gear in use in some docks. A manufacturing company in London recently manufactured a type of ship mooring which can be instantly slipped by one man on board the vessel. From a fire protection point of view it would be of great assistance to firemen if all berths were fitted with some such quick release mechanism.

### Fires in Port Installations

No study of fire fighting in Port would be complete without reference being made to fires in dockside buildings and warehouses. Over the past ten years many serious fires in dockside buildings have occurred in different parts of the world, involving loss of life and huge monetary losses. The destruction by fire of a large refrigerated warehouse, for example, can be a major disaster to a port authority, involving as it does the Shipping Companies having to divert their ships carrying perishable cargoes to other ports providing the necessary facilities.

Probably the most disastrous fire to occur within the period in question was that of the Luckenbach Steamship Co. Pier at Brooklyn, New York, on the 3rd December, 1956. The pier was heavily loaded with highly combustible material including inflammable liquids, baled sizal, foamed rubber and a shipment of 37,000 lbs. gross weight of Cordeau detonant fuse estimated to contain 7½ tons of Class " A " explosive. The fire was caused by sparks from a welding torch, being used to repair the roof, falling onto the foamed rubber. The rubber was in bales wrapped in burlap which is a woven material of coarse jute, hemp or flax with a loose fibrous surface. The fire spread with tremendous rapidity over the burlap and whilst the sprinkler valve system operated it was quite incapable of controlling the fire. So many waterheads opened up that the water supply was not sufficient to provide an adequate quantity of water at effective pressure. About twenty-five minutes after the alarm was raised an explosion occurred which killed 10 people. The monetary loss amounted to 7,600,000 dollars and the consequential loss caused by the fire, including the destruction of berthing and storage facilities would amount to a further huge sum.

Holland, too, has had her share of large dockside fires. In 1948, on the 11th September, the Amsterdam Fire Brigade were called to a fire at the cold storage warehouses known as Amerika-Australië, located between Haven and Binnenhaven. The ware-

## *Fire Fighting in Ports—continued*

house contained meat, butter, eggs, fish, vegetables and other foodstuffs. The fire originated on the second floor of the five storied Amerika and it is thought that it was due to tar boiling over during repair work. The fire fighting, after an initial explosion, had to be carried out from outside and owing to the peculiar construction it was almost impossible for the water jets to reach the heart of the fire. The combustible nature of the building ensured that the fire spread was rapid and the second and higher floors of the warehouse, with contents, were destroyed. The building was not protected by a sprinkler installation. The main lessons from this fire were that where the floors were of concrete, the floors did not collapse and that a sprinkler installation would probably have confined the fire in its incipient stage.

The second large fire concerned two large waterside warehouses on the River Zaan which were destroyed by fire on the 15th October, 1954. The buildings were adjoining and known as the Czaar Peter Warehouse and the Nederland Warehouse occupied by C. Kamphuys Fabr. N.V., and were used for storage of cocoa butter. cocoa beans and other cocoa products, nut kernels, timber doors, paint and other combustible commodities. The warehouses were of four and five storeys respectively. The cause of fire was that workmen had been engaged in loading a barge with cocoa bean husks from the first storey of the Czaar Peter. They had been using a portable electric lamp fitted with a conical metal shade and connected to the electricity supply in the storey above. When their work was finished, this lamp was placed, alight and pointing downwards on a jute bag containing cocoa bean husks. Owing to the shade no light was visible to the workmen who left it switched on when they stopped work at 10 p.m. Heat from the lamp ignited the bag and its contents and the fire spread rapidly throughout the building. By the time the alarm was raised at 5.15 a.m. the Czaar Peter warehouse was seriously involved and an intense build up of heat had taken place in the Nederland Warehouse, due to liquified burning fat flowing through the spaces under and round the fire resisting doors. The severity of the fire was due primarily to the delayed discovery of the outbreak and the combustible nature of the contents. The failure of the fire resisting doors between the two warehouses and the lack of sills to prevent burning liquid flowing from one building to the other were contributory factors to the spread of fire.

Britain has not been free from fires in dockside buildings in recent years. The largest of such fires took place in the South No. 2 Branch Gladstone Dock Shed, Bootle, Lancashire, on the 9th November, 1949. The damage resulting from this fire is estimated to be in the region of £2,000,000 and is one of the most costly to have occurred in this country. The building was of ground floor and two storeys, of reinforced concrete throughout, the roof being rendered with 1½-in. covering of asphalt. Three fire resisting concrete party walls, having sliding double iron doors divided the building into four parts. Highly combustible merchandise including rubber, cotton seed and wool were stored in the warehouse, the rubber alone amounting to over 5,000 tons. The cause of fire has never been ascertained although it is certain that it started in the north west corner of the second floor. Before the fire was finally extinguished over twenty-four hours elapsed and thirty-five pumps and three fire boats had been in use. During the course of the fire six vessels had to be moved to a place of safety. The building was not sprinklered.

Whilst the Gladstone Dock fire is the largest, there have been a number of other serious dock fires including the Cargo Transit Shed, South No. 3 Canada Dock, Liverpool, on the 19th August, 1950; Fulham Wharf, Townmead Road, Fulham, London, S.W.6, on the 7th September, 1950; Dock Shed, Humber Dock Side, Kingston-upon-Hull, on the 13th July, 1951, and the Transit Shed Berth No. 54 Stobcross Quay, Glasgow, on the 28th September, 1953. In each of these fires extensive damage was caused to the port facilities with the consequent lowering of the efficiency of the unit and even the risk of the loss of trade from abroad.

Both at home and overseas it is obvious that a great deal of thought must be paid to the whole question of the protection of port buildings against the ravages of fire. The lessons from fires involving port facilities must be carefully studied and the Authorities concerned would do well to ask themselves if their "house

Firemen about to board the "Empress of Canada" on fire at Liverpool, January, 1953.

was in order." It will be a national tragedy if our valuable resources are dissipated without thought in the future. It is an old Fire Brigade maxim that "what burns never returns" and this is as true to-day as when it was written.

Fire protection of port facilities can be divided up into a number of basic headings which are listed as follows:—

**1. The Actual Structure of the Buildings Including**

(a) Building Materials.

Great care should be paid to the selection of all materials used in the construction of the building. It is strongly recommended that at least four hours fire resistance should be aimed at for floors and walls. Combustible wall or roof linings should be avoided at all costs.

One of the most disastrous fires in recent years was that involving the General Motors Corporation Plant at Livonia, Michigan. which covered an area of 1,502,500 sq. ft. (approximately 34½ acres). The tremendously rapid spread of fire was caused in the main by the bituminous and gravel coating on the metal roof deck and by the fact that the huge building was without division walls to control fire spread.

(b) Size of Compartments.

It was always a mistake to put "too many eggs into one basket" and this can be said to be a truism of fire prevention. Within the limits of economic working, warehouses should be compartmented into the smallest possible units, so that a fire, once started, can be fairly readily controlled.

(c) Proximity of Other Buildings or Berths.

Where the building is close to other buildings or to important shipping berths, consideration must be given to the protection of openings from direct flame or radiated heat. The desirability of having a non-combustible roof covering which is proof against flying brands from adjoining fires, is obvious.

(d) Staircase Design.

All stairways must be enclosed by fire resisting walls giving at least 4 hours' protection. Door openings should be protected by fire doors provided with automatic fastenings, e.g. springs, weights or fusible link control.

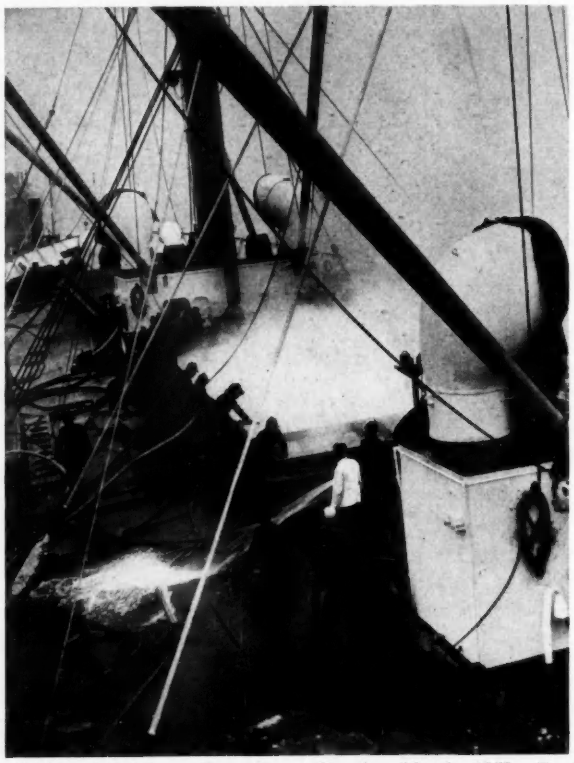
## *Fire Fighting in Ports—continued*

Particularly in new buildings, smokeproof towers forming an enclosed staircase should be constructed. Access to this type of staircase from the building is by a balcony or vestibule open to the outside of the building. Smoke from a fire cannot enter the tower which provides first class egress from the building and also gives the firemen valuable access to fight fires.

(e) Vertical and Horizontal Openings.

Vertical openings such as lift shafts, light wells, belt or pipe holes, must be protected to a standard equal to that of the fire resistance of the floors.

Door openings must be protected by approved type fire resisting doors designed to close automatically on the outbreak of fire. Such openings should be kept to the bare working minimum because there is no doubt that every opening in a wall is a potential hazard.



The "City of Colchester" on fire at Dundee, March, 1953. During unloading a metal cable struck a coaming, producing sparks which ignited bales of jute. The fire spread to involve three holds.

(f) "British Standard Definition No. 476—1932 for Fire Resistance Incombustibility and Non-Inflammability of Building Materials and Structures" should be carefully followed to ensure that the elements of structure in a building are of a satisfactory standard of fire resistance.

### 2. Means of Escape in Case of Fire.

The danger of persons being trapped by a fire starting in a warehouse is very real. Highly combustible goods stored almost to roof level are not conducive to the occupants being readily able to see the exit route in case of fire.

Exit doors and staircases should be readily accessible and should be indicated in such manner as to lead even a stranger from anywhere within the building to street level.

### 3. Water Supplies for Fire Fighting.

(a) **Internally.**

Dry Rising Mains. In multi-storeyed warehouses dry rising mains to all floors terminating in the appropriate fire brigade couplings ($2\frac{1}{2}$-in. female instantaneous couplings in Britain) positioned in the staircase at the entrance to each storage level and provided with clearly indicated inlets on an outside wall at the entrance to the building, should be provided ($2\frac{1}{2}$-in. male instantaneous couplings in Britain). The British Standard Specification for Fire Hose Couplings is No. 138—1954.

Sprinklers or Mulsifying Systems. The lesson from nearly all the fires occurring in warehouses is that had a sprinkler or mulsifying system been installed the fire would have been held in check until the arrival of the fire brigade.

In cases where sprinklers have failed to check the fire, this has almost invariably been due to excessive storage of highly combustible materials. Such storage forms a "fire load" which is too great for the amount of water available in the system to control the fire.

Hose Reels. In order that small fires can be quickly dealt with by staff on the spot, hose reels should be installed to cover all the premises These reels are connected to water mains and consist of a revolving drum on which is a length of $\frac{3}{4}$-in. or 1-in. tubing. Reels fitted with some form of automatic valve which turns on the water supply when the nozzle is taken to the fire is strongly recommended.

(b) **Externally.**

Drencher Systems. Buildings which are close to adjoining premises forming an exposure hazard should be protected by a drencher system which forms a water curtain between the building, commencing at roof level.

Water Mains. Although in a port area there is always an abundance of water available it is much better that the fire brigade are provided with adequate fire mains of at least 6-in. diameter. Pressure and flow to be sufficient for the task for which they are provided. Hydrants should be well sited and indicated and so placed that there is little likelihood of them being covered by the normal impediments of dockland.

The standard outlet for hydrants in Britain is the $2\frac{1}{2}$-in. round thread in conformity with British Standard Specification No. 750—1950.

### 4. Fire Alarm Systems.

(a) **Internally.**

No large building can be considered to be adequately protected unless an automatic fire alarm is fitted terminating in the nearest fire station. By this means the fire brigade receive instant notification of a fire having started in a building quite automatically throughout the twenty-four hours of the three hundred and sixty-five days of the year, without the weaknesses associated with human watchmen.

There are very many different types of alarms manufactured but basically the majority operate when the temperature near any of the alarm heads rises above 155 degrees fahrenheit.

(b) **Externally.**

The need for the provision of a fire alarm system in the dock area had already been touched upon but bears repetition. The alarms should be either of the break glass or of the type which are fitted with a transmitter/receiver so that the fire station operator can converse with the caller.

These are simply the basic facets of the complex problem of adequately protecting port installations against the ravages of fire. It is obviously quite impossible to develop further this subject in an article of this size and much has been left unsaid but, here again, the management of any docks or port installation wanting to seek advice on this subject have only to approach the Chief Officer of their Local Authority Fire Brigade who will gladly offer all possible assistance.

No one country has all the "know how" on this vast subject of fire prevention and it would be in the interests of all the Maritime Nations if a permanent international Committee could be formed, composed of all interested parties, **including fire fighting officers,** and given the task of formulating standards of fire equipment for use on board ship. What was achieved in 1948 was a tremendous step forward towards international safety from the ravages of fire on board ship. The time has now come for this to be taken one step forward, to what must be our goal—that of ensuring that firemen the world over can fight fire on board a vessel no matter what her port of origin and find that standard equipment has been provided for their use.

# Screw Piles and Cylinders

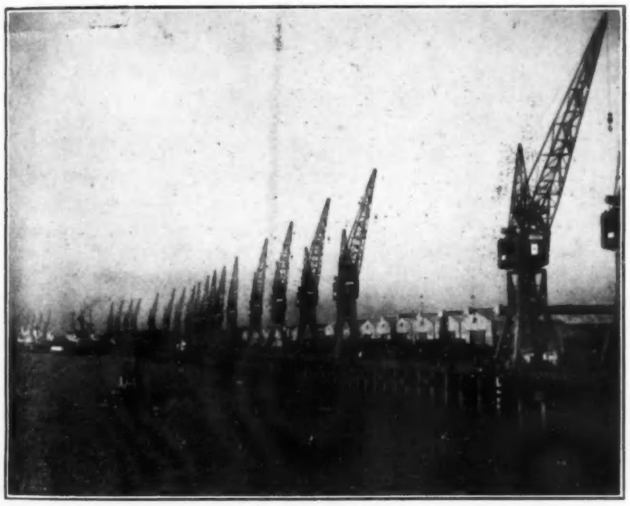
## Their Early Development and Use

*(Specially contributed)*

The idea of driving a pile shaft into the ground by means of a helix attached to its end is a very old one. In the early stages, the helix was rather in the form of a spiral modelled on the corkscrew and constituted a method of getting the pile into the ground without greatly increasing the end bearing area. As time went on, however, it was realised that by increasing the diameter of the helix, additional bearing capacity became available which did not require a corresponding increase in the shaft diameter which was often determined by practical considerations of stiffness and torque during driving.

The increase in the diameter of the helix, however, brought with it a number of problems such as difficulty of adequate guiding due to pressure on the leading edge of the helix, adequate strength in the material of the helix and rapidly increasing power required for driving which, up to that time, had been done by means of some type of hand-capstan.

The problems of guiding were overcome partly by improvements in the helix design and partly by the use of guide frames operating on the shaft. The strength of the helix blade was increased first by improving the quality of the cast iron and later, as diameters increased, by using cast steel. The lack of power in the driving apparatus was overcome by the use of a power-operated capstan.



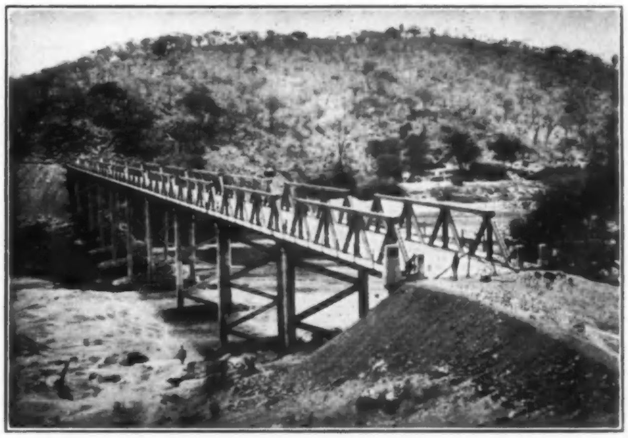
New quays in Pakistan founded on 2,520 screw piles having 7-in. diameter shafts with helices 5-ft. and 6-ft. in diameter. (Fig. 1)

With these developments came parallel development in the design of the shaft which moved from mild steel rounds up to 7 or 8-in. diameter to mild steel tubes, cast iron tubes and finally cast iron cylinders 36-in. in diameter for which helices up to 8-ft. in diameter were used. Fig. 1 shows a structure using solid steel shafts.

The use of this steel or cast iron in foundation work in itself presented a problem as the cost of material increased and it became increasingly difficult to obtain.

In order to overcome these difficulties the Foundation Research Department of Messrs. Braithwaite Ltd. commenced a development programme which eventually resulted in the production of the so-called "Screwcrete" cylinder. The earliest example of this was in the foundations for the bridge shown in Fig. 2.

A steel casting $\frac{3}{8}$-in. thick and 42-in. internal diameter was bolted to the helix, in this case 8-ft. in diameter, and driven into the ground by means of a central mandrel made up of sections of the old 36-in. dia. cast iron cylinder. As the helix was open-ended the soil which was forced up inside it was removed by means of an air-lift. On reaching foundation level the aperture in the screw was sealed by means of concrete placed under water and the cast iron mandrel removed. An appropriate reinforcing cage was then placed in the casing and concrete poured to form the finished cylinder. Later, in the same contract, the cast iron helices were replaced by a more economical type made up from welded mild steel plates concrete filled.



Road bridge in Rhodesia founded on 15 "Screwcrete" cylinders 42-in. diameter with 8-ft. diameter helices. Penetration into river bed 45-ft. Note that piers are a prolongation of the foundation cylinders. (Fig. 2)

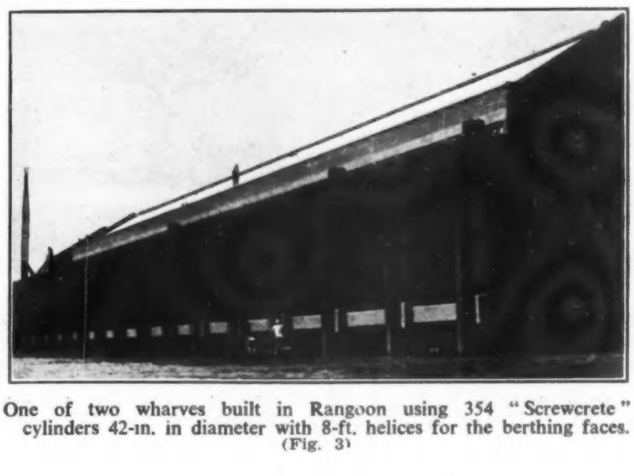
It was soon realised that the use of such heavy casing plate was unnecessary and it was eventually replaced by an $\frac{1}{8}$-in. thick casing corrugated to withstand the pressures to which it was submitted due to water or earth. At the same time more powerful driving arrangements were developed by which a closed-end helix could be used thus eliminating air lift pumping which was expensive.

With the introduction of this casing came the need to develop single purpose machinery for curving welding and beading the casing for use on construction sites in remote places to which the cost of transporting ready-made casings would be prohibitive.

As has already been mentioned, the cast iron and cast steel helices were replaced by those welded from mild steel plate, concrete filled, a process which was continuously developed until the point was reached where it was possible to eliminate the plate and, provided the load was not too great, use a helix entirely of reinforced concrete. The old cast iron mandrel was replaced by steel tubes of the same diameter with improved methods of joining.

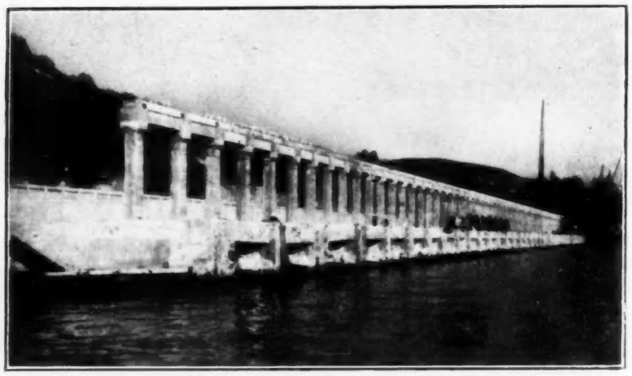
The old capstan with the problems of finding adequate attachment for the long anchor rope and of guiding resulting from unequal slopes or lack of alignment of the two parts of the rope was finally developed into a screwing machine. This combined in one unit a capstan together with two cranes which enabled the one machine to deal with all handling, assembly and driving. This machine can be conveniently mounted on barges for marine work, the resistance to the torque of the capstan being taken up by the barge anchors.

It will be appreciated that provided the barge is adequately anchored the driving of the "Screwcrete" cylinders can be carried



One of two wharves built in Rangoon using 354 "Screwcrete" cylinders 42-in. in diameter with 8-ft. helices for the berthing faces. (Fig. 3)

*Screw Piles and Cylinders—continued*



Wharf on the Bosphorus in Turkey founded on 152 "Screwcrete" cylinders 42-in. diameter with special helices in reinforced concrete. The gantry is designed to carry the forward legs of 5 coal handling transporter bridges.
(Fig. 4)

out effectively from floating craft. At first certain difficulties were found in accurately locating the cylinders on the sloping surfaces of seabed or river bank but this was overcome by means of guiding devices and by a long point below the helix which acted as a locating spigot.

Figs. 3 and 4 illustrate marine structures in which the "Screwcrete" type of cylinder has been used.

The method of driving a cylinder into the ground by means of the helix and a rotary motion is not limited to foundations in soft silty material. The powerful modern plant now available will drive a helix through a sunken barge or into sand and gravel, with the assistance of built in jetting equipment if necessary, or into material containing small boulders. The method cannot, of course, be used for foundations in rock or when the soil contains large boulders. For such conditions other methods of driving large cylinders have been developed.

In suitable conditions the 42-in. diameter cylinder can be designed to carry loads in excess of 300 tons. Helices up to 9-ft. 6-in. in diameter have been used although, if site conditions made it necessary, even larger diameters could be successfully designed and driven.

The above loadings, of course, apply only to the 42-in. diameter casing and if small loads are to be dealt with then the cylinders can be driven using the other two standard casings available, namely 19-in. and 22-in. diameters.

The advantages of the "Screwcrete" cylinder which in some cases also extend to the ordinary screw pile can be summarised as follows:—

1. There is no vibration during driving which can be carried out from floating craft practically as efficiently and speedily as on land.

View of "Screwcrete" cylinders for a jetty in Southern Turkey using 8-ft. diameter reinforced concrete helices.
(Fig. 5)

2. When the cylinder is driven, it constitutes, in effect, a tubular shuttering into which reinforcement can be placed and concrete poured to suit whatever the design loading on the shaft may be. The steel casing protects the concrete from the ill effects of aggressive soils or waters during the maturing period of concrete.

   In normal conditions the casing below low water level will not deteriorate during the useful life of the structure supported by the cylinder, and thus provides a large increase in the factor of safety. It should also be realised that the casing has considerable inherent strength, thus the effects of vibration or casual loading during construction do not affect the concrete. This applies especially to marine work.
3. Because the major proportion of the superimposed load is carried by direct bearing on the helix the permissible load can usually be computed with considerable accuracy from the results of the test on the soil.
4. Large caps very suitable for use with precast or prestressed concrete structures, can be accommodated on the cylinders. When properly designed the connection between the cylinders and the superstructure can be considered as fixing the upper end of the cylinder so that it acts as a fixed column in respect of horizontal and vertical loads.
5. Finally the screwing technique enables a foundation of large carrying capacity to be constructed very rapidly even when cylinder length and penetration are considerable. Cylinders of a total length of the order of 120-ft. with a penetration of 90-ft. or more have been driven.

Fig. 5 shows a typical example of 42-in. diameter "Screwcrete" cylinders in a jetty foundation driven of a penetration of 60-ft. in water 30-ft. deep. Using floating plant the 69 cylinders were driven in 70 working days.

# The Use of Rubber in Dock Fendering

## Review of Recent Developments

The problem of protecting both ships and waterfront structures from the forces of impact and lateral thrust during berthing operations or during the action of storms on the moored vessels, has confronted engineers for many generations. In the days of the small wooden vessel the fenders in use were not needed for more than a minor absorption of impact energy and were, consequently, of a very crude type. The ship's wooden hull was capable of absorbing the majority of the impact of berthing. With the advent of metal ships and the progressive increases in the size, weight and speed of vessels, more effective protection for both the ships and the piers at which they berthed became essential.

There are many types and forms of fendering and they may be constructed from many different kinds of material. They may be solid baulks of timber floating between the ship and the quay, a vertical pile, a block of rubber, a spring, a hydraulic buffer, or even an old motor tyre. Regardless of size and method of construction used, however, they are all intended to perform the function of absorbing kinetic energy so as to protect both the ship and the harbour structure from the impact forces of the vessels.

Since the last war many changes in port operation have taken place throughout the world. With the increased numbers of ships in service and the resulting increase in international trade many ports have had to add to the number of berths available to take care of the extra shipping and in many instances vessels are now required to come alongside quays and jetties where conditions of weather and tide are far from favourable. For this, and other reasons, damage is by no means uncommon. A comparatively slight contact with a quay may cause considerable damage to a ship. The damage to the quays, of course, is dependent on the material used in their construction and their strength and the force of the impact upon them. Nevertheless, it is by no means uncommon for a jetty or pier to be rendered unusable for con-

## *The Use of Rubber in Dock Fendering—continued*

siderable periods after being struck heavily by a ship.

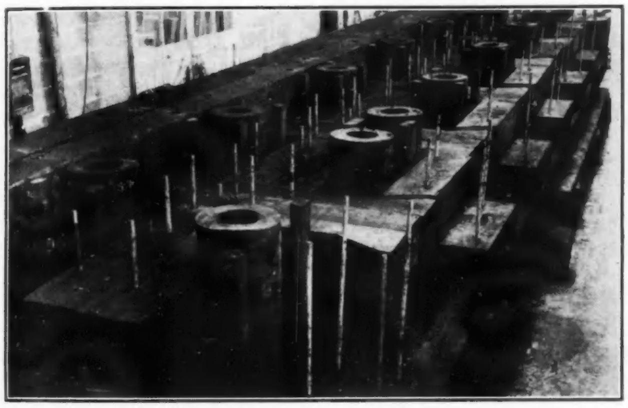
Local labour costs, particularly in the East, have risen enormously and this has affected the cost of all dock services, including, of course, the cost of fendering. In view of the frequency and extent of berthing damage and the financial loss involved, arising from the present day cost of repairs to ships and installations plus the loss of time, it will be seen that it is no longer economical for any dock to regard fendering as a necessary evil which cannot be avoided.

**Compound Rubber.**

Rubber is one of the most universally used commodities in our modern civilisation. It can be made of very high quality materials and compounds or from a minimum of the base material known as rubber and a very large quantity of other materials.

Compound rubber has proved itself to be reliable, relatively inexpensive and easily obtainable. It has three important characteristics and when these are employed in a proper manner there is no better material, either in service performance or cost. The three characteristics are:—

**(a) Rubber in Compression.** Rubber can be compressed and will recover its original shape many times without deterioration. When used in compression rubber will support heavy loads and absorb very considerable kinetic energy. The development of large, high loading capacity rubber components has made possible the use of rubber in compression between main dock structures



A compression fender under construction. It is fitted with eighteen lengths of rubber tubing 15-in. o.d. x 7½-in. i.d. x 4-ft. long.

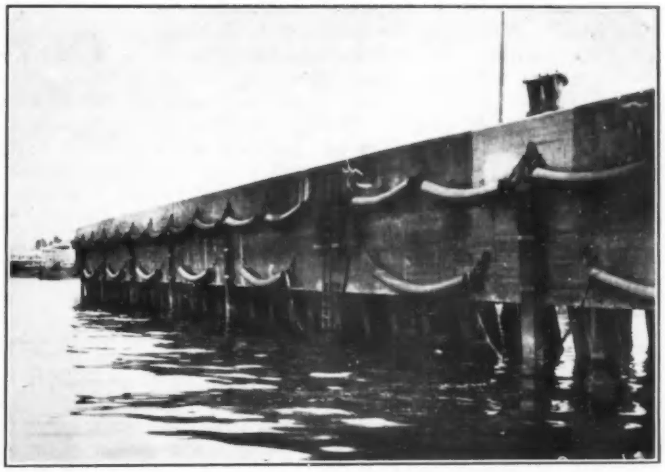
and fender piles or independent fender systems. Due to the movement of the rubber " spring " the loads on the dock structure are dissipated and economies are possible both in materials and the cost of structure design.

**(b) Rubber in Shear.** This application of rubber basically consists of rubber sandwiched between two metal surfaces, to which it is bonded. When the metal components are moved in opposite directions the rubber is distorted and resists the forces, thereby absorbing energy.

**(c) Resistance to Abrasion.** The properties of compound rubber to resist abrasion are becoming appreciated more and more. These resistant qualities make rubber well suited as fendering on the working faces of jetties and quays.

**Applications of Rubber Fendering.**

Perhaps the first method of using rubber for fendering was to hang old car or lorry tyres along the quay wall. A development of this method, first used in 1933, utilises heavy rubber tubing which can absorb fairly large quantities of impact energy per foot length. Hung along the working face of a quay wall or solid pier it performs the dual function of resisting abrasion and absorbing energy. It has the advantage of being easy to use, requires no additional construction, can be rapidly and inexpensively replaced and has a low unit cost. The particular needs of every installation can be dealt with simply and effectively. Should the



General view of rubber fenders at Pulo Bukom.

rubber fender become damaged accidentally it is not completely destroyed as some of the material may still be used satisfactorily. The berth need never be closed solely on account of fender maintenance. If it becomes necessary to change a fender the changeover can be made in a very short time—the time taken for one ship to leave the berth and another to come alongside. Oil jetties in Venezuela and other places average nearly one tanker per berth per day and at this frequency the time taken in berthing is valuable. Some of these installations, fitted with rubber fenders of this type, without any expenditure on maintenance or repairs, have already handled over 10 million tons of shipping per berth.

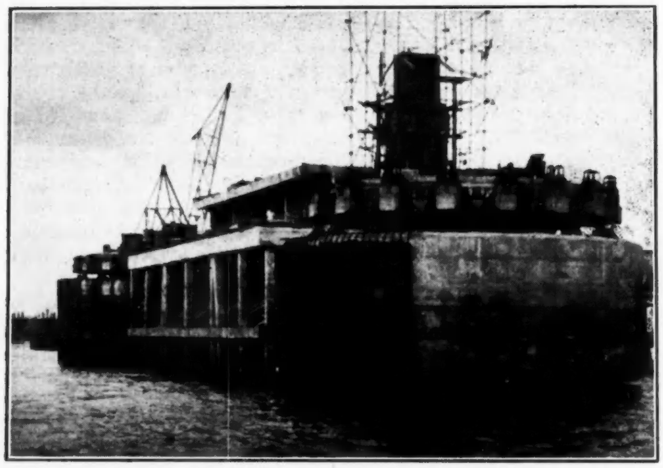
**Compression Fenders.** There are many examples of the way in which rubber can be used with other fendering materials. Compression fenders make use of rubber in conjunction with timber to form a strong, durable type of fender which will perform effectively for many years with little cost of upkeep. They contain a number of compressible rubber compound cylinders, each of which is designed to absorb a predetermined amount of energy and which are sited symmetrically within an interlocked framework of timber in such a manner as to afford adequate stability. The timber framework provides buoyancy, support and protection for the rubber units. The fender is easily compressible and conforms to the shape of both vessel and quay when floating

Rubber tubing 15-in. o.d. x 7½-in. i.d. in use on oil dolphins at Singapore.

*The Use of Rubber in Dock Fendering—continued*

between them. It is completely independent and self contained and is only attached to the quay, or to the vessel, by wire, chain or rope moorings. It is protected against the entry of debris by heavy timber sheathing which completely encloses it.

The interior generally, and the rubber units are almost completely filled with water. When the vessel strikes against the fender, either at right angles or obliquely, it immediately begins to compress and thus to absorb energy. First, the water contained within the framework is expelled, but this expulsion is restricted by the positioning of the external sheathing, and by the time the rubber units have been completely compressed and all the water expelled, a considerable amount of external pressure has been absorbed. Thereafter the rubber itself is compressed sufficiently to absorb the final pressure. By gradually increasing the nature of the resistance an effective shock absorber is created, thus preventing damage to quay and vessel. Timber distance pieces are fitted within the framework in such a manner as to prevent the fender being compressed beyond the limit at which all energy has been absorbed. At this point the fender becomes solid, for all practical purposes, and by this means the rubber units are protected from any damage to which they would otherwise be subjected by excessive pressure. Immediately upon the removal



Vertical rubber fenders at marine oil terminal, Butcher Island, Bombay.

of external pressure the fender will automatically expand to its normal condition by reason of the size, strength and resilience of the rubber units, which at the same time refill with water. The fender is then ready to absorb the next shock of impact or pressure.

**Fender Piles.** Another method of using rubber with other materials is to place a rubber block between the deck of the pier to be protected and the head of the fender pile. The impact load at the deck level will be absorbed by the block acting in compression.

**Buffer Units.** For the last 30 years or longer rubber bonded between two metal surfaces has been used in various industrial forms from very small blocks to fairly large ones. This method has now been adopted in a buffer unit in which the rubber is bonded to two steel plates and mounted on both the head of the fender pile and the deck of the jetty. Any movement in a horizontal direction is restricted with an accompanying absorption of energy. Doubts have been expressed about the effects of corrosion and rust on the bond between the rubber and the steel plates on this and similar types of buffer. It is felt that in order to preserve the steel plates of the "sandwich" they will have to be surface protected or made of non-corrosive metals so that continuous maintenance will not be required.

**Fender Buffers.** The Neidhart fender buffer is a device that makes use of the compression characteristics of rubber. Working on the principle of a level acting against rubber cylinders that compress as the lever turns, this fender has an advantage in that it has the ability to take longitudinal loads at the same time as it overcomes lateral loads. Vertical loads are mainly taken by the pier after being transmitted by the buffer. Again there is some doubt about the effect of corrosion on the interior of the metal components but this would be overcome by the use of non-corrosive metals.

**Gravity Fenders.** Rubber fendering of the heavy tubing type mentioned earlier can be used effectively on the face of gravity fenders. Gravity fenders consist of a mass of material, usually concrete, suspended by metal components from the coping of a jetty. They absorb energy because when they are moved out of their normal position their weight swings inwards and upwards. Gravity fenders range from comparatively small weights up to individual components weighing as much as 800 tons. Those installed on the Baker dolphins at Kuwait each weigh 40 tons whereas those in use on a berth at Bombay weigh approximately 650 tons each.

Regardless of their size, however, gravity fenders are only capable of absorbing energy. The face of the fender has to be fitted with protective material which, primarily, must be able to resist abrasion and protect the gravity fender itself from damage because the mass of the fender can only be made to move when the inertia has been overcome.

The use of rubber as a protective material offers great advantages. The rubber provides a soft cushion between the gravity fender and the ship. Not only does it protect the ship but transfers the force to the gravity fender by a gradual process and not as shock.

The three oil berths at Bombay designed by Sir Bruce White, Wolfe Barry and Partners were fitted, from the beginning, with rubber tube fenders of 12-in. outside diameter and 6-in. inside diameter. The first berth was commissioned on 15th February, 1955, and for the period ending 31st December, 1956, 250 tankers were brought alongside, ranging from 10,000—50,000 tons. The second berth, commissioned on 12th July, 1955, handled 154 tankers up to 31st December, 1956.

The beam type of berth designed by Sir William Halcrow and Partners is another form of gravity fender. In this case it rests on piles but the weight rises as the fender is deflected. In Singapore there are three Halcrow beam type berths, one of which is fitted with rubber fenders. They have been in service for three years without showing any signs of wear.

**Absorbing Increased Berthing Forces.**

During the last ten years tankers have risen in size from 15,000 tons to over 60,000 tons and new tankers are being designed in the 100,000 tons class. Berths designed for 20,000 ton tankers a few years ago will have to be modified to handle the larger tankers with their increased berthing forces. By using rubber fenders on these berths it is possible to go a long way towards absorbing this extra force without the need to carry out extensive structural modifications. The combined cost of rubber fenders and the structural alterations, in any case, will be less than the cost of strengthening the structure and continuing to use rigid fenders.

Fire is a particular danger in tanker operation. As there are no exposed metal components with which the berthing ship can come into contact rubber fenders provide a considerable safety factor against the potential spark hazard.

**General Conclusions.**

In conclusion, it may be said that rubber can be used in conjunction with almost any type of pier structure. In the case of rubber tubing, however, a continuous solid backing is also advisable. A further advantage of rubber is that it is easily replaceable because of its light weight and ease of handling and if replacement units are available there is no need for any special repair equipment. Used in either shear or compression, correctly designed rubber units should not transmit more than 10 per cent. of the impact to the main structure. Normal design is for a movement of not more than 45° in shear and for no more than 50 per cent. deflection in compression.

It is significant that rubber as a fendering material is now being used in dock work in more than 50 different countries under widely different conditions of tide, climate and service.